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INTENSIVE SALAD PRODUCTION

including some vegetables

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INCLUDING SOME VEGETABLES

BY

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Foreword by

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TO
MY FATHER

Foreword

There is untold wealth in the soil, but it was never intended that it should be extracted without labour, and the man with the most knowledge and who takes the greatest pains obtains it most readily. Intensive methods of crop production involve hard work, and in the culture of crops by controlled systems, unless the controller is knowledgeable and painstaking, the result is failure; yet certain growers have shown that the man who possesses a sound working knowledge of intensive methods can achieve success. Further, the grower can obtain a sufficient hold over production to vary the growth of the crops to mature at desired times to meet the needs of the market, and the regulation of market supplies is often a very great advantage.

The intensive systems—there is more than one system—are well known and generally practised on the Continent, and should be better known and more widely used in this country. Perhaps this is due to the shortage of literature on the subject.

Numerous books on the intensive systems are available in foreign languages, but few English books deal exclusively with the subject or in any great detail. Mr. Quarrell proposes to rectify this omission and has written a book that deals exclusively with intensive methods of production of salads and early vegetable crops, and his book can be commended to all who wish to practise the system or study the methods.

To write convincingly of the intensive methods of production, an author should have a working experience of the system, and in this Mr. Quarrell is indeed fortunate, for much of his experience was gained with Mr. F. A. Secrett, one of the foremost leaders in the industry, at Holly Lodge Farm. Indeed, many of the systems outlined in the book were practised on Mr. Secrett's farm.

An expansion of the intensive systems of vegetable culture is not easy in this mechanical age, because of the shortage of dung, but, as the author shows in a most excellent chapter, the necessary humus may be supplied to the soil by decomposing vegetable waste, by the use of Adco or cyanamide, or by using either the Scarlett or the Indoré Process. Science has now shown that the animal is less necessary than it was in providing humus for our soils.

The author stresses also the need of a water supply, and as most vegetables contain 90 per cent of water no one could deny its importance. With a controlled system of production man should not rely on nature, for at times rain may not come when most needed, and be in abundance when least needed. These two paragraphs show that the author has not limited his writing to purely horticultural matters concerning lettuce, cauliflowers and carrots and their production, but has dealt fully with the needs of the systems to produce the choicest salads. Most aspects have been covered, and the author can claim to have produced a comprehensive account of the intensive system.

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*London, S.W.*1

Preface

The introduction of tariffs on early salads and vegetables as from January, 1932, has resulted in a rapid development of production of these crops on intensive lines. New methods have been introduced and foreign systems of production adapted to conditions in this country. Coupled with the demand for salads and early vegetables, created by decreased importations from the Continent, the popularity of this produce with the general public is steadily growing. Consequently, there is ample room for further development, providing the grower realizes that the quality of the produce must be good to meet the high standard of public taste. Moreover, the fact that importations are still considerable indicates that there remains a market to be won.

This book has been written mainly for the commercial grower and student, but the private and amateur gardener should find the methods described easy to apply to his own particular conditions. A special endeavour has been made to present a detailed and practical account of the chief systems of intensive cropping now practised in Britain. Such descriptions would be of little value to the grower if the production of salads only was given. Those vegetables that form an essential part of the cropping sequences have, therefore, received full attention.

The inclusion of an account of French gardening may be criticized in view of the alarming decrease of the supplies of horse manure. It should be remembered, however, that many methods adopted for "cold" systems of intensive cropping were derived from French gardening. This system, on the lines described in this book, is being successfully carried out in England to-day, and growers who study the methods employed will probably find much that can be adapted to less intensive cropping systems. Moreover, French gardening may be carried out for a few years only, as a means of building up the fertility of the land, so that the production of first-class crops may follow without the use of hot-beds. The development of soil-warming for frames may eventually provide a means of substituting manure hot-beds. Some account of the chief methods available are described in Chapter VI.

The general cultivation of individual salad crops is dealt with in a separate section of this book, and as far as possible reference has been made to the place of such crops in intensive cropping programmes. The production of tomatoes and cucumbers under glass has not been dealt with, since space would not permit of adequate treatment, and so much has been written elsewhere on these crops.

Owing to the high cost of production of early salad and vegetable crops, the importance of adequate control of diseases and pests can hardly be overstressed. This subject has, therefore, received special attention, and an endeavour has been made to give such concise notes as will, the author hopes, enable the grower to recognize the commoner diseases and pests, and to take up-to-date control measures against them.

A certain amount of repetition has been necessary in order to avoid troubling the reader to refer back frequently to other pages.

The author's grateful thanks are accorded to Dr. H. V. Taylor, O.B.E., A.R.C.S., V.M.H., for kindly contributing the Foreword, and for making certain suggestions in regard to the text. Early market produce growers owe much to Dr. Taylor for his work in connexion with the imposition of import tariffs, and this represents but one of his many activities in the interests of the horticultural industry.

The author also wishes to acknowledge his indebtedness to Mr. F. A. Secrett, F.L.S., V.M.H., the well-known pioneer of intensive market-garden work, under whose personal supervision he received an important part of his training; to Mr. G. H. Tawell, N.D.H., of the Hertfordshire Institute of Agriculture, for kindly devoting much time to reading the proofs, for making valuable suggestions, and for lending certain of the photographs; to Mr. W. Adams, B.Sc., of the University of

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C. P. QUARRELL

WINCHESTER, 1938

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Chapter One

Sites and Soils

The choice of ideal sites and soils for any horticultural enterprise is seldom, if ever, available. Many growers take up intensive salad production as a section of their existing market-garden or glasshouse nursery, and hence use the material available. Nevertheless, a discussion of the chief factors that should be considered when selecting a site and soil for this work on a commercial scale, should be of some interest even to those whose choice of land is limited to that already in their possession.

At the outset it may be stated that if the soil available is of a texture far removed from the ideal, or such that a fair resemblance to the ideal cannot be achieved at reasonable cost, then the grower had better leave early salad production entirely alone. In the writer's opinion soil texture is by far the most important factor concerned in the production of early crops. It cannot be too strongly emphasized that the grower who attempts to produce early salads on soil of a decidedly unsuitable nature (e.g. very heavy clay), may spend a lifetime fighting against those soil conditions and probably lose the battle in the end.

The following are some of the most important points to be considered:

(1) Soil—especially drainage and texture.
(2) Aspect.
(3) Climate.
(4) Water supply for irrigation.
(5) Proximity to markets.
(6) Availability of labour.

(7) Supplies of organic manure.

(8) Transport facilities.

(9) Security of tenure and availability of further land to allow for expansion.

(10) Absence of severe infestations of the soil by pests and diseases.

Soil. A badly-drained soil is useless for the growing of salads and other vegetables, and no amount of manuring will induce such a soil to produce good crops.

It is well known that clay soils are frequently badly drained, but few realize that poor drainage may occur even in sandy soils. Occasionally in the latter there is an impervious layer of stones cemented together by iron oxide at varying depths of 6 in. to 2 ft. or 3 ft. from the surface. This forms the so-called "iron-pan" or "pudding-stone", and may completely prevent free drainage. Sometimes a thin band of clay or fine silt may exist below surface level and have a similar effect. Even sloping land may not always be well drained. When the expense is considered worth while, poorly-drained soils may be improved by means of agricultural drain-pipes, rubble drains and open ditches, and considerable benefit sometimes results when the soil is thrown up into "lands" or raised beds.

Heavy clay soils and similar soils that remain cold and wet for long periods, and are difficult to cultivate, are useless for early cropping, as not only are early cultivations impossible but plants are slow in growth and late in reaching maturity.

For similar reasons, chalk soils are often unsuitable, and are, moreover, usually low in humus content.

If it is thought worth while, it is possible to improve heavy clay soils by drainage, deep cultivations and liberal application of sand and ballast. Lime tends to improve the texture of clay soils, but it is the excess of lime (in the form of chalk) that makes a chalk soil so sticky when wet. This is a mechanical factor due to the small size and large quantity of very fine chalk particles.

The most suitable type of soil is a light sandy loam, well drained, easily worked and having a fair content of humus or organic matter. On such soils it is possible to work advantageously even after rainfall, which would make heavier types intractable for several days or even weeks. Thus early cultivation, seed sowing, planting, etc., may proceed. Further, such soils warm up easily, inducing rapid growth, and the texture encourages quick root action.

The humus content of the soil is very important, and heavy dressings of farmyard, horse or other organic manure must be applied annually. During dry weather a light soil which has been well enriched with humus may appear dust-dry on the surface, but if the top inch of soil be brushed aside the remainder will be found to be fairly moist. The level of the water table is of great importance, for if too low the soil may dry out too readily in summer, but if too high, waterlogging may result occasionally. Valley soils or alluvia are frequently very suitable, and it may be found that in old mature river valleys the subsoil water is slowly moving as an underground stream flowing towards the river or the sea. This is advantageous, if not too near the surface, as it provides a supply of "sweet" water as a reservoir for the subsoil.

The nature of the subsoil is a matter of considerable importance. Gravel subsoils are suitable for early crops, but generally need very heavy manuring to prevent drying-out and to increase fertility.

A clay subsoil beneath a deep sandy soil may be advantageous providing the drainage is satisfactory.

A soil auger will be found useful and several soil samples should be taken, as in many districts great variation occurs within small areas. It is advisable to inspect the site and soil during winter and summer if possible. The prospective grower may receive considerable help in his search for suitable land, if he consults the local County Horticultural Adviser, or the Provincial Advisory Chemist.

In private gardens and on a small commercial scale salads may be grown in frames containing a specially mixed compost.

Aspect. Land with a slight slope towards the *south* or *south-east* is preferred, since full advantage of early spring sunshine is obtained. If some of the land faces north or west it may prove useful for summer crops and seedling production in summer. If the whole of the land slopes to the north-north-east or north-west it is not suitable for early cropping, or, indeed, for vegetable growing of any description.

Shelter. Shelter from strong gales is important even for low-growing crops such as lettuce. Wind induces excessive loss of water from the leaves by transpiration, and buffets and bruises the plants. On the sea coast, where further damage may be caused by the salt spray carried by gales, this is very important, as such sites may be otherwise excellent from the climatic point of view.

Shelter may be provided by:

(1) Hurdles, fences or walls, which are useful for protecting frame-yards. Hurdles are particularly useful for providing temporary protection to out-of-door crops.

(2) Hedges. The following plants are recommended: *Cupressus Lawsoniana*, slow in growth but most reliable. *Cupressus macrocarpa*, not wholly recommended, but widely planted for its quick growth. Too often it proves disappointing owing to its weak root-hold and to the tendency to die off in patches, especially when frequently clipped. On the sea coast shelter belts consisting of unclipped *trees* of *Cupressus macrocarpa* or *Cupressus sempervirens* are fairly reliable. *Thuja occidentalis*, and other Thuja species, planted about 2–3 ft. apart, are usually reliable. Quickthorn (*Crataegus* spp.) and privet (*Ligustrum* spp.) planted alternately 9–12 in. apart are very effective. When given proper attention privet quickly makes an excellent hedge that will withstand even salt-laden gales to a remarkable degree. Certain species of Escallonia and *Pittosporum nigrescens* are suitable only in the milder regions of this country (e.g. Cornwall), but where successful they make excellent hedges and at the same time themselves form a source of income by the sale of the foliage to florists. Lilac is not so suitable, as it tends to grow straggly and is deciduous. *Lonicera nitida* planted 18 in. apart, "staggered" in two rows, is good for low hedges, though it needs very frequent clipping. If a row is planted on either side of a wire or chestnut fence, sufficient support is obtained to make satisfactory hedges up to 4 or 5 ft. in height. Beech (*Fagus sylvatica*) is an excellent hedge plant, although it is deciduous. If clipped in August, the subsequent young shoots produce leaves that remain dead on the twigs throughout the winter. Hornbeam (*Carpinus betulus*) is said to be more suitable

for light soils. On the sea-coast *Euonymus japonicus* and *Griselina littoralis* thrive.

(3) Tall screens of *Pinus insignis* (*radiata*) and other species, or *Populus nigra* (Lombardy poplar) and other species.

(4) Temporary protection by screens of hessian canvas or small-mesh wire netting, coir netting or lath and wicker hurdles. Belts of crops, such as sweet corn, kale and runner beans, are used sometimes as windbreaks.

The subject of screen hedges has received considerable attention in recent years. Many growers believe that in very exposed positions the object of a screen should be to "filter" or retard the force of the wind rather than attempt to make a solid barrier. Hedges have also been planted with the object of deflecting the gales, by planting so that the hedge is not placed at right angles to the direction of the prevailing wind but at approximately 45 degrees to it.

Climate. Early salad crops are obviously more easily produced in districts where the climate is such that severe frosts are uncommon and spring sunshine is plentiful. Some districts in the southern counties of England, and in certain sheltered coastal regions of Wales, and the west of England, offer these advantages; but this climate is of little value unless the soil is suitable. On the other hand, providing that an early type of soil is available, these crops may be profitably produced in other parts of the country where the climate is less favourable. Salad crops are grown commercially in Dutch light frames on suitable soils in such counties as Yorkshire, Lincolnshire, Worcestershire, etc. These crops have been a feature of the market gardens and French gardens of Middlesex and Surrey for many years.

Fog, particularly when charged with smoke and fumes from big cities, is a serious handicap to all plant life.

Excessive rainfall is a disadvantage, because not only does this result in a lower average soil temperature but the hours of sunshine must necessarily be reduced. A rainfall of between 22 and 30 in. per annum is generally considered suitable.

Sites that are very exposed to east and north-east winds, or are situated in hollows forming "frost-pockets", must be avoided.

Water Supply for Irrigation. If intensive work with the use of frames is contemplated, an ample supply of suitable water for irrigation must be available. Main water, if procurable, usually has the advantage that the initial outlay is small, since no expensive pumping plant has to be installed. Main water is frequently very "hard", however, and therefore not ideal. Many growers instal pumping outfits and sink wells to obtain their water. If this is done the grower is faced with a large initial outlay for plant, but running costs are comparatively low. Moreover, in times of drought the grower is independent of emergency restrictions imposed on the main water supply. Care must be taken that the water contains no toxic salts and is not excessively charged with fine silt and fine sand particles likely to clog or wear the pumping apparatus (see Irrigation, Chapter Four). Additional supplies of water may be obtained by collecting into tanks all roof-drainage water from packing sheds and neighbouring premises.

Proximity to Markets. Modern transport is so efficient and speedy that fresh produce can be very quickly conveyed hundreds of miles in a short space of time, and provided it is properly packed, the produce reaches the consumer in a good fresh condition. In spite of this, however, a site near to good markets still has advantages. Every hour makes a difference to the quality of vegetables and salads between the time of gathering by the grower and consumption by the public. Further, the high cost of transport, and sometimes additional packing and marketing costs, may considerably reduce the profits. On the other hand, with the development of transport by air it is possible that distance from good markets will become less important in the future. It should be remembered also that sites near large cities are frequently very expensive to rent or purchase and very often are subjected to the effects of fogs and an impure atmosphere. Further, such market gardens are usually surrounded by houses, so that little land is available for increasing the area under cultivation.

Transport Facilities for Produce. The site should preferably be near to a railway station, with an adequate train service, and to good roads. In some districts the railway company encourages the grower to use the trains by offering reduced transport charges for market produce sent from a particular area.

Many growers send their produce to market in motor lorries, which certainly have the advantage of convenience and of reducing the handling of the produce, conveying it straight from grower to the wholesaler or retailer.

When the grower can depend upon several local retailers calling on him regularly for supplies, transport charges, market charges, and often special packing charges are avoided.

In some areas local carriers arrange to call on growers in the district to collect produce and convey it to market, where it is handed over to the wholesaler for disposal, or it may be sold direct to the retailer by the carrier.

Labour Supply. If the business is large, labour becomes an important item. Sufficient labour should be available both for permanent employment and for casual work during rush periods, particularly for harvesting and marketing the crops. Thus the farm must be situated near a town or village. Workers of the right type are becoming increasingly difficult to obtain, and frequently the grower has to compete for his labour recruits with near-by factories. The grower can offer the advantages of an open-air life, but often finds it difficult to pay the high wages obtainable at the factories. Women and girls soon become expert at work such as gathering, preparing and packing produce for market, and are invaluable on market gardens.

Supplies of Organic Manure. In the early part of the present century it was possible to obtain for the market gardens around London almost unlimited supplies of horse manure from the London stables. Nearly every conveyance which carried the produce to Covent Garden and other markets returned with a load of manure. The development of mechanical means of transport has resulted in a serious scarcity of horse manure. Even farmers use tractors for ploughing and other tillage work, and now have insufficient horse manure for their own farms. On the other hand, some vegetable growers are beginning to keep pigs and cows mainly for the manure produced. However, methods have been, and are being, devised to produce a substitute for these manures, and these are discussed in Chapter

Three. If the grower is situated reasonably near a riding school, racing stables or the like, he may be able to arrange a long-term contract with the owners, in which event he usually agrees to collect and remove the manure, to keep the stables clean, and to pay an agreed sum for the manure.

Security of Tenure and Availability of Further Land Should the Business Expand. The Market Gardeners' Compensation Act of 1908 and the Agriculture Act of 1932 protected the tenant from loss upon being given notice to quit the land.

The compensation for "disturbance" includes standing crops and residual manures. In spite of this a prospective grower is well advised to secure as long a lease as possible or to purchase the land freehold.

Even freehold land is not necessarily secure, as county councils and other public bodies may override the wishes of the grower and obtain the right to purchase part or all of the land. The grower is usually adequately compensated, at any rate at the market value of the land.

A successful grower is often handicapped by lack of available land to enlarge his existing market garden. The purchase of a plot or plots some distance away is not generally so satisfactory, as it means divided organization and the dual expense of overheads, such as transport, packing facilities and supervision.

Absence of Severe Infestation of the Soil by Pests and Diseases. The danger of purchasing or renting land which is so infected with pests and diseases as seriously to jeopardize any chances of successful cropping on it, is somewhat rare. It is, however, a possibility to be borne in mind, particularly in regard to old nurseries or market gardens. If glasshouses are part of the nursery the soil in them may be infested with root diseases and pests, the eradication of which is likely to prove a difficult and expensive problem. Potatoes and other outdoor crops are subject to certain pests and fungus diseases that may be carried over in the soil. Even newly-ploughed pasture land may be infested with wireworms, but usually these are most serious during the second and third years after ploughing up. In the purchase of old arable land or nurseries general cleanliness and past maintenance of fertility are points to be investigated.

A grower who decides, five years in advance, to leave a farm, may be sorely tempted to take out of the land all that is possible, without attempting to maintain the fertility of the soil by suitable manuring.

Chapter Two

Soil Fertility—Soil Cultivations —Drainage—Liming

In a book of this size it is obviously impossible to deal fully with the subject of soils. To the practical grower a knowledge of soils in general and of his own land in particular is of paramount importance. Every successful grower studies his own soil, watches its behaviour under varying seasonal conditions, observes the results of every tillage operation and endeavours to know its likes and dislikes. After several years of careful observation and experimenting he begins to "know" his soil as no other man knows it, so that his treatment of this soil is probably different from others in small but important details.

The only way in which a man can get to know his soil is to work on it with his own hands, meanwhile constantly using his powers of observation and deduction.

From the grower's point of view the main purposes of soil are to provide an anchorage for the plant and to form a source of food and water. The soil is a storehouse of plant nutrients and should preferably be of such a texture that the plant roots may ramify between its particles without undue resistance. In a fertile soil each soil particle is surrounded by a thin film of soil-water in which are dissolved plant foods obtained from the soil itself. It is only in the dissolved form that the plant is able to take up these food materials, and as this solution is taken up by the plant roots so more salts are extracted from the soil-storehouse by the soil-water. Between these soil particles there are air-spaces varying in size according to the nature of the soil. The importance of these air-spaces will be realized when it is remembered that all parts of the plant respire, or breathe, and therefore roots require some air or oxygen.

A fertile soil is not dead, inert matter, but is teeming with millions of micro-organisms, which, by feeding themselves, are extremely important to plant life.

Micro-organisms that are beneficial to plant life need a well-aerated soil in order to thrive. They feed on substances that are locked up in the soil in a form unavailable to the plant; but, when the micro-organisms die, these substances are left in a form easily assimilated by the roots of the plants. The conditions in a badly-aerated soil favour the development of those bacteria that are harmful to plant life. In practice this means that a soil cannot be fertile unless it is well cultivated, so that sufficient air is mixed with the soil for healthy root development and efficient working of the beneficial bacteria. Deep cultivation obviously extends the area through which plant roots may profitably extend. It should be remembered also that many artificial manures need to be transformed by these soil organisms before they are available to the plant. It follows that no soil that is badly drained can be fertile. A water-logged soil can contain little or no oxygen, since the air-spaces are filled with water. Further, a water-logged soil is cold and probably "sour" or acid, under which conditions both plants and bacteria beneficial to plant life cannot thrive.

Drainage. The provision of artificial drainage is a very expensive operation and therefore every effort should be made to obtain land that is naturally drained. Free drainage is assisted by deep cultivation and by growing crops on raised beds. Land may be drained by means of open ditches, rubble, brushwood, mole-drains, or tile- and pipe-drains. It is not always wise to take for granted that the land is well drained because drain-pipes were laid many years ago. Frequently it is found that such drains have been put in too deeply in the soil or that some are broken or blocked up. When land has been ploughed for many years to the same depth a "plough-pan" may be formed. This is a layer of hard, compacted soil that may impede free drainage, but if a subsoiling attachment is used, its formation is prevented.

Details of the methods and practice of land drainage may be found in many horticultural books (see Refs. below).*

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* B. W. Adkin, *Land Drainage*, London Estates Gazette, Ltd.
Smith, *Profitable Culture of Vegetables*.
Watson, *Gardeners' Assistant*, Vol. I.
Newsham, *Horticultural Notebook*.

Lime. The fertility of the soil is largely dependent on the presence of a sufficient amount of calcium carbonate, or lime. Soils that are very deficient in lime are usually acid, and, as with badly drained soils, applications of most manures to such soils may be regarded as a waste of time and money. Few vegetable crops thrive on a very acid soil, and one of the effects of applications of lime to such a soil is the correction of this acidity. Crops of the Brassica family, such as the turnip and cauliflower, when grown on acid soils, are frequently affected with a serious fungus disease known as Finger-and-Toe (*Plasmodiophora brassicæ*). Continued applications of lime coupled with good drainage considerably help to control this disease.

On heavy clay soils, applications of lime have a beneficial effect on the texture of the soil. Lime causes the fine clay particles to flocculate so that the soil is better drained and aerated, and of a more suitable texture for plant growth. The heavy, sticky nature of some soils may be due to the presence of large amounts of fine silt or fine chalk particles, and applications of lime to these soils does not tend to improve their texture.

The presence of adequate lime is necessary to make the soil suitable for the life of the micro-organisms responsible for the decomposition of the organic matter, and also those that fix atmospheric nitrogen. The plant is thus provided with large quantities of nutrients that would not otherwise be available.

Much lime is removed from the soil annually in the drainage water, and replacements are necessary.

Certain artificial manures, such as sulphate of ammonia, tend to "use up" some of the lime in the soil; others, such as nitrate of soda, do not deplete the lime content appreciably; whilst manures such as calcium cyanamide, nitro-chalk, and nitrate of lime, actually contain lime.

Sea-sand often contains a high percentage of lime, and this is used extensively in Cornwall and elsewhere by vegetable growers.

Forms of Lime. Lime may be purchased in so many forms that some growers find it a little difficult to decide which to buy. Whether sold as calcium oxide (quicklime), calcium hydroxide (hydrated lime), or carbonate of lime (ground chalk or limestone), manufacturers now usually state its equivalent in terms of calcium oxide (CaO) or oxide of lime, and this serves as a useful basis for comparison. From the chemical point of view there is little difference between the value of the three chief forms of lime mentioned above, providing equivalent amounts of calcium oxide are applied to the land. It should be remembered, however, that the more finely-divided forms are the most efficient, because they are distributed more uniformly and effectively in the soil. Ground limestone and ground chalk are sold in a very finely-divided state, but slaked or hydrated lime is even more finely divided.

Some of the commonest forms of lime are:

Quicklime, also called *burnt lime*, *lump lime* or *caustic lime*, containing upwards of 90 per cent of calcium oxide (CaO). It is usually slaked by exposure to the air, or by the addition of water before mixing with the soil. Slaked lime is difficult to distribute and unpleasant to handle. It must be applied shortly after delivery, and dressings of quicklime should be applied several weeks before sowing or planting. It is not very suitable for light soils.

Ground Lime. This is quicklime that has been crushed to a fine powder. It is easy to handle and distribute, and breaks up into still smaller particles when slaked in the ground. It is usually delivered in bags but cannot be stored for more than a week or two as it absorbs moisture from the air, swells and bursts the bags.

Hydrated Lime. Hydrated lime is obtainable under many trade names and is really quicklime that has been slaked under controlled conditions and contains approximately 68 per cent CaO. It sells at a higher price than quicklime, but owing to its purity and extreme fineness of division is used extensively for horticultural purposes.

Ground Limestone. This is a form of carbonate of lime or calcium carbonate. Usually it contains approximately 50 per cent CaO and its effectiveness depends on the fineness to which it is ground. Compared with quicklime it has certain advantages, since it is easily handled and distributed and can be stored indefinitely without deterioration or breaking of the bags. It is not harmful to plants when applied in large quantities, and is excellent for light soils. On the other hand, in order to supply equal amounts of calcium oxide, twice as much ground limestone as quicklime must be applied. This means double expense in transport charges and labour costs for applying it to the ground.

Chalk. Chalk is a form of soft limestone and is commonly applied as quarried in many parts of the country. It is spread over the land in the autumn and subsequently the frosts and cultivations break down the lumps sufficiently. It contains about 50 per cent CaO.

Ground Chalk is obtainable in many districts and it possesses similar properties to ground limestone.

There are many other forms of lime, such as carbide waste lime, "small lime", limestone dust, and waste carbonate of lime from sugar-beet factories.

In comparing all these forms of lime the grower has to consider the following points:

(1) The net price quoted.
(2) The calcium oxide content.
(3) The degree of fineness of division.
(4) The cost of transport.
(5) The cost of distributing on the land.
(6) Suitability for the desired purpose.

Time and Rate of Application. For best results lime must be well mixed and uniformly distributed in the top soil. This is most easily achieved if the lime is applied in as dry a condition as possible, such as during a dry spell of weather in spring or autumn, depending upon the cropping plans.

On normal soils 10 cwt. of quicklime or 1 ton of ground chalk per acre applied annually will usually be quite sufficient. It is now possible to have a soil analysed and its lime requirement obtained in terms of the quantity required per acre.

Chapter Three

Manures and Manuring

Chemical or artificial manures are of immense value to the market gardener, but the most important manures, for the production of high-quality salad and vegetable crops, are organic. These manures supply the soil with humus, a complex substance that for practical purposes may be regarded as the product of decay of organic materials, such as green crops, straw, farmyard and stable dung, hoof and horn, shoddy, etc. Generous applications of these organic manures are of particular importance to the grower of early salads and vegetables, since the best soils for these crops are light sandy loams which use up humus very quickly and are unable to hold moisture when deficient in this material.

Value of Humus. The value of humus to the soil can hardly be over-estimated. It improves the physical condition of the soil; provides energy for the soil micro-organisms; retains plant foods applied to the soil, preventing them from being washed out in the drainage water; it holds moisture as a sponge so that considerable supplies of water are steadily available for the plant roots; and being dark in colour absorbs heat from the sun, and is therefore said to make the soil warmer. In short, humus is the very basis of soil fertility, and therefore inorganic chemical manures can never entirely replace farmyard manure or be an equivalent substitute. If, however, chemical and animal manures are used in judicious combination, considerable economy can be effected, and the resultant crop weights and quality are often improved.

Farmyard and stable manures are becoming increasingly difficult to obtain and many large producers of vegetables now keep their own livestock mainly for the production of manure. The problem for the small grower is more difficult, though frequently he is able to keep pigs as a profitable side-line.

The decrease in the supplies of animal manure has been, to a very great extent, compensated by the remarkable development in the manufacture of high-grade fertilizers, the use of which has undoubtedly prevented thousands of acres of farm and market-garden land from becoming worthless for crop production. These artificial manures are now available at reasonable cost in a very wide range of forms to suit various purposes. A great deal of research work has been done on the subject of plant foods and their effects on plant growth. Further study has resulted in the production of fertilizers to provide these foods in the most suitable form for the purpose desired. This work includes practical trials of the fertilizers with various crops and on different soils and in different seasons. Much work still remains to be done, particularly on the manuring of flower, vegetable and salad crops. The work is by no means easy, and results are often confusing and difficult to interpret. Many factors are involved and not the least important are the weather conditions prevailing.

Good growers always observe carefully the results of any manurial applications, making notes on the time of application, the weather conditions, etc. Some forms of manures are more effective on certain types of soils than on others, and often comparatively small areas of land are found to consist of many different types of soil. If, as often occurs, the grower undertakes a little experimental work on his own land, he should not confuse the results of a manurial trial by other factors, such as that of employing a different method of cultivation from that practised the previous year. Further, it is always wise to include a few untreated or "control" plots scattered about at random among the treated plots. If these points are not observed the grower is likely to misjudge the good or bad effects of any particular manure. In the absence of control plots the results obtained cannot be attributed to any particular treatment, as other factors, such as good or bad weather conditions, might largely account for the behaviour of the crops.

Farmyard Manure. It is well known that the three plant nutrients most likely to be deficient in soils are nitrogen, phosphoric acid and potash. Farmyard manure contains all the three foods and is therefore a complete manure. It varies in composition, however, and is always deficient in phosphoric acid—hence the commendable practice of adding approximately ¼ to ½ cwt. of superphosphate to each ton of dung, after spreading or as a separate dressing. Further, nearly all the readily-available nitrogen and most of the potash come from the urine, and if not well stored, much of this is lost. If the manure contains large quantities of unrotted straw it may cause a temporary deficiency of nitrogen if applied to the soil immediately. This is caused by the bacteria feeding on the soil nitrogen owing to the large excess of carbohydrates supplied in the fresh straw. Dressings of nitrogenous fertilizers are therefore useful in such instances. The nutrients in dung are present in different states of availability, so that the plant is given a slow and steady supply of food over a long time, and this accounts partly for the residual effect of organic manures during succeeding seasons.

It is an established fact that the plant also requires very small quantities of other minerals, such as calcium, chlorine, magnesium, manganese, boron and sodium, some of which are present in organic manures. It is now suggested that the presence in animal manures of special hormones, and of substances akin to vitamins in human foodstuffs, have important reactions on plant growth, and so may be more important than their chemical composition would indicate.

The quality of the manure varies considerably according to the type of bedding material used. Straw bedding proves the best manure, and bracken and peat-moss are also good. Wood shavings or sawdust are sometimes used for bedding, but produce poor quality manure. Horse manure is richest in plant foods, while the manure from meat-producing animals, such as bullocks and pigs, is a good second, and that from milking cows is lowest. Poultry manure is rich in all the three chief plant foods, especially in nitrogen and phosphoric acid, but is difficult to handle unless dried, and drying greatly increases its cost of production. However, poultry dung produces excellent manure, if properly composted with material such as straw, peat or vegetable refuse, kept moist, turned occasionally, and allowed time to decompose.

Substitutes for Farmyard Manure. The problem of providing sufficient humus to maintain the fertility of the soil is one that confronts every grower. Experiments have been made and others are in progress with the object of finding an efficient and economical substitute for organic manures, mainly from the point of view of the humus they supply. Much work has still to be done, but the following notes on the methods now being actually practised by some growers should be of interest.

Green Manuring has been practised by farmers and gardeners for many years. The most suitable crops for the purpose are mustard, rape, clover, peas, lupins, rye and tares. Besides adding humus to the soil the green crop also provides a certain amount of plant food, being that which it collected during growth, and which otherwise might have been lost from the soil. Moreover, the pod-bearing types of green crops add nitrogen to the soil through the action of the associated leguminous root bacteria, which "fix" atmospheric nitrogen. Mustard is probably the most popular green-manuring crop, as it is very quickly grown and does not rob the soil of so much moisture as some of the leguminous crops.

Lupin (*Lupinus* spp). It is usual to sow the annual blue and yellow varieties together. They may be sown from April to the end of July, but must be ploughed in before they are frosted. About 1 cwt. of seed is sufficient for one acre, drilling it from ½ to 1 in. deep in rows 12 in. apart.

Rape (*Brassica rapa*). Rape may be sown in April to plough in during August, but if sown in July or August it is usually not ploughed in until the following spring. If broadcast, 10 to 15 lb. of seed are required, but if drilled about 8 to 10 lb. per acre are sufficient.

White Mustard (*Brassica alba* (syn. *Sinapis alba*)). White mustard can be sown from April to early August. It must be ploughed in before damaged by frost, and late summer sowings do not mature sufficiently. If drilled, about 12 to 14 lb. of seed are sufficient, but when broadcast about 20 lb. will be necessary.

Improved Methods of Green Manuring. It has been found that the beneficial effects of green manuring can be greatly improved by treating the material by the following methods before ploughing in:

(1) *Addition of Farmyard or similar Manure.* A dressing of about 20 tons of dung per acre is applied on top of the mature green crop after cutting, and then the whole is ploughed or dug into the soil. The manure probably assists the decomposition of the green crop, developing a form of "composting" underground.

(2) *Application of Calcium Cyanamide.* This substance is applied at the rate of 3 to 5 cwt. per acre on top of the mature green crop after cutting. The land is then ploughed, preferably after rains have made the material wet. Decomposition follows quickly and the nitrogen added by the calcium cyanamide assists the bacteria responsible for this work and itself increases the fertility of the soil.

(3) *The "Scarlett" System.* This method, evolved by Mr. Robert L. Scarlett, C.D.A.,* is dependent upon the use of two successive green crops, each of which is treated with cyanamide as in Method 2, coupled with certain cultivations. It is claimed that by this method not only is the humus content of the soil increased and its general fertility raised, but neglected and weedy land can be effectively cleaned.

The land should be ploughed in the autumn or early spring and sown with tares at the rate of 1½ cwt. per acre in February or early March. These flower about late June and are then cut up with a heavy implement and 3 to 4 cwt. per acre of calcium cyanamide spread on top of the material, preferably when it is damp. The whole is left for six or eight days and then ploughed under. The land is then harrowed and rye is sown at the rate of 2 bushels per acre, not later than the third week in July. This is cut up and ploughed under before the end of December.

It is again ploughed in spring and potatoes are planted, adding phosphate and potash to the drills at planting time.

These methods will probably appeal most to the large-scale producer who can afford to forego the "cash" crop that might otherwise be grown on the land during the time that the green crop occupies the land.

Composts. For many generations it has been the custom of gardeners to collect all plant waste material and weeds into a corner of the garden to form a "rubbish heap", placing any stones in another heap. At the end of the season the rotted material was dug into the soil in order to dispose of it and at the same time provide a substitute for manure.

In recent years the scarcity of animal manure has led to considerable research into methods of utilizing these waste materials to make an efficient substitute for animal manures to supply humus to the soil. As a result of these investigations, much is now known regarding the conditions necessary to produce rapid breakdown of the material, and practical methods have been devised for applying this knowledge in farms and gardens.

Straw, haulms of potatoes and peas, weeds, grass cuttings, tree leaves, etc., have been successfully treated by the methods described below. Experiments are being made to convert graded and selected material from town refuse into "synthetic" farmyard manure, by means of the Indore Process. With each method, success is largely dependent upon careful attention to detail, especially regarding the aeration and moisture content of the compost heaps.

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* R. L. Scarlett, C.D.A., *Scottish Journal of Agriculture*, Jan., 1937, XX, No. 1.

(1) ADCO AND CALCIUM CYANAMIDE METHODS.

The Adco method was devised by Rothamsted workers when investigating the decomposition of straw. They found that this decomposition would not take place readily, even when kept moist and warm, unless certain substances were added to increase the activity and numbers of bacteria responsible for the work. The outcome of this valuable research was the formation of a company which placed on the market the now well-known "Adco".

Calcium Cyanamide may be used instead of Adco and, at the time of writing, is considerably cheaper. Since this substance is rich in nitrogen, it is sometimes advisable to add potash and phosphates to the soil as a separate dressing and thus provide a balanced manure for the crops.

Composting. For the best results the material to be rotted down should be placed in layers 6 to 9 in. deep, between each of which is a dressing of Adco (1 lb. per sq. yd.) or calcium cyanamide (½ lb. per sq. yd.), on the "sandwich" principle. The material is watered as the work proceeds and should never become too dry nor exceedingly wet, but kept reasonably moist. The heap must be made as compact as possible. The whole heap must be turned with forks (making a fresh heap) about every 3 or 4 weeks, placing the outside material of the first heap in the centre of the new heap.

Messrs. Adco, Ltd., recommend the following quantities of Adco and water for treating various substances:

QUANTITIES OF ADCO AND WATER REQUIRED TO TREAT 1 TON OF MATERIAL

	Adco *cwt.*	*Water* *gal.*
Cereal straw, maize straw, etc.	1½	800
Dried grasses, mixed refuse	1	600
Fresh green material	½	400

The manufacturers of cyanamide recommend the following quantities of cyanamide and water to treat 1 ton of material:

	Cyanamide cwt.	*Water gal.*
Cereal or other straws	¾	800
Mixed refuse	½	600
Fresh green material	¼	400

It will be found that only about one-quarter of the volume of water can be absorbed in the first application. It is usual to wait about a week or until decomposition has started and then apply the remainder in three applications at three-day intervals. It usually takes 3 to 4 months to decompose the material to the condition of "long manure" and up to 6 months for "short manure". The time taken depends mainly upon the prevailing temperature (quicker in summer) and on the efficiency of the operator in carrying out the instructions, and finally on the nature (soft or woody) of the material to be decomposed.

(2) THE INDORE PROCESS. The Indore method of humus production was devised by Sir Albert Howard, C.I.E., M.A., formerly Director of Plant Industry, Indore. This method has met with considerable success in the tropics, and experiments are now in process to ascertain its efficiency under the climatic conditions of this country. Briefly, the main points regarding this process are:

(*a*) All available waste vegetable matter, such as weeds bracken, water weeds, etc., are collected and mixed in the process of collection. All fresh green material must be withered before composting. Even woody materials, such as prunings and reeds, may be used, if first crushed by placing on a service road, or cut up into short lengths in a chaff-cutter.

(*b*) The compost heaps are made on the sandwich principle, commencing with a layer of about 4 in. of vegetable wastes, on top of which a layer of 1 or 2 in. of animal manure is placed, and then a dressing of chalk or soil containing lime. A layer of vegetable waste is added and the series of layers continued until a height of 4 ft. is reached. The last layers should be manure and then soil. The heaps must be fairly open to provide aeration. The height of the freshly-made heap should not be more than 4 ft. After settling it should not exceed 2½ ft. After about three weeks the heap is turned over in the usual way. After a further 4 or 5 weeks it should be turned again, and in three months from the making of the compost heap it should be ready for application to the land. It is possible that by pumping air through the mass of compost material, much labour in turning might be avoided.

(*c*) The material should be reasonably moist at all times so that the heaps must be watered whenever necessary. Rainfall will often keep the material sufficiently wet. The material should never become sodden, and in some climates it may be necessary to shelter the heaps from excessive rains.

(*d*) The ideal site for the heap is one sheltered from winds and facing south.

Although it is claimed that the heat of fermentation produced in these compost heaps by the Indore process destroys all diseases and pests if properly carried out, the grower would be well advised not to use any seriously diseased vegetable material in his compost heaps, but consign all such to the bonfire.

Experiments conducted by Dr. Bewley at Cheshunt Research Station * proved that diseased tomato stems infected with Verticillium Wilt were still a potential source of disease after being composted by the Adco process. In any event, the average grower will not be able to see that his men carry out the work as concisely as appears to be necessary to achieve complete disease destruction.

(3) PILE DUNG. This is the name given to the material produced by a composting system that has been practised by Cornish market gardeners for many years. Town refuse, waste paper, weeds, seaweed, and sea sand containing lime, are utilized, and animal manure is sometimes added. The material is built up as far as possible on the sandwich principle, often into very large heaps. The heaps are not turned or watered artificially, but in the mild Cornish climate and high annual rainfall experienced, effective disintegration takes place after twelve months' standing.

Other Organic Manures.

Shoddy. This is a waste product from wool and cotton manufacturers, and is excellent material for use instead of or in addition to dung. One or two tons of shoddy may be used in place of one ton of dung. An analysis will be supplied on demand, and this is important as the nitrogen content may vary from 4 to 15 per cent, depending largely on the amount of wool present. Shoddy provides a slow but steady supply of nitrogen, and has a marked beneficial effect on the soil texture.

Hoof and Horn Meal. This contains usually 12 to 14 per cent of nitrogen, and is a very valuable organic manure. It used to be considered so slow in acting that it had no effect on the first year's crop. The experience of at least one prominent grower of market-garden crops, and the results of some recent investigations conducted at the John Innes Institute, Merton, Surrey, indicate that this manure is much quicker in acting than was previously supposed. It appears that hoof and horn provides a steady but slow supply of nitrogen to the plant starting shortly after its application but lasting over a long period. Since bacterial action is intensified during warm weather it is probable that the release of plant food from hoof and horn applied in autumn is greatly increased during the spring and summer, thus supplying extra food just when the plant needs it, under the improved climatic growing conditions.

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* *Annual Report*, Cheshunt Experimental Station, 1936, No. 22.

Fish Guano or Meal. This is a useful horticultural manure containing 8 to 10 per cent of nitrogen and sometimes some phosphates. Certain distributors add potash and phosphates in suitable amounts to form a more complete manure. Its pronounced fishy smell is said to attract rooks.

Meat Meal. Meat meal contains 7 to 8 per cent of nitrogen and 10 to 20 per cent of tricalcic phosphates. It decomposes fairly readily in the soil, is easy to handle and distribute, and tends to improve the soil texture slightly.

Soot. Soot has probably been used on gardens for centuries. Chemical analysis shows that it contains only a low percentage of plant foods (e.g. 1 to 5 per cent N), yet the practical grower has great faith in its efficiency as a manure and soil improver, and to some extent as a deterrent against pests. The best soot is that obtained from domestic fires, after storing for 6 to 12 months in a dry place. Soot obtained from furnace chimneys (e.g. factories) is of less value, except mechanically, as the high temperature of the chimneys and the excessive draught result in the loss of most of the ammonium salts into the atmosphere. An average dressing of soot for intensive work is 40 bags per acre.

It should be remembered that soot is an expensive source of nitrogen, and some experiments conducted on brussels sprouts in the Eastern Counties showed that 600 lb. of sulphate of ammonia (applied in three dressings) gave equally as good results as one ton of soot (there being equal amounts of nitrogen in both these applications). The cumulative effect of soot on the soil, however, is difficult to estimate and value.

Seaweed. Seaweed is extensively used by vegetable growers, when it can be obtained cheaply (e.g. coasts of Cornwall, Devon and Sussex, parts of Scotland, the Channel Islands, Ireland, etc.).

It contains appreciable amounts of potash and nitrogen, but some phosphatic manure, such as basic slag, should be mixed with it to make it a more complete manure.

Peruvian Guano. This material consists of the accumulated excretion of sea birds. The natural material contains from 9 to 13 per cent of phosphoric acid and from 7 to 10 per cent of nitrogen, both in various states of availability. Sometimes the substance is acid-treated to obtain a quicker-acting manure, and potash is added to improve the balance. It is a safe manure to use on most crops but is rather expensive.

Bone Manures. The oldest form of phosphatic manure is crushed bones.

Bone Meal contains approximately 22 per cent phosphoric acid and 4 to 5 per cent nitrogen.

Steamed Bone Flour is more finely divided and contains approximately 30 per cent phosphoric acid and 1 to 2 per cent nitrogen. As a source of phosphates for the plants these manures are particularly valuable on light soils, in regions of light rainfall and low water supply, and for soils deficient in lime.

Dissolved Bones fertilizer is hardly superior to superphosphate although usually appreciably dearer. It is more suitable for chalk soils.

Dried Blood. Dried blood is remarkable for its readily-available organic nitrogen. This property, coupled with its fine state of division, make it a very quick-acting manure. The pure product contains from 9 to 10 per cent nitrogen, and a little phosphates, but if it is dried with lime it is not so rich. It is too expensive for general market-garden use and experiments on certain crops, using sulphate of ammonia as the comparison, indicate that there is little to be gained by using blood as an alternative to the cheaper fertilizer.

Inorganic Chemical or Artificial Manures.

Nitrogenous Fertilizers. These promote vegetative growth, but excessive amounts should not be applied, as such tend to make the plants too soft and "sappy", and consequently more subject to diseases and pests, and more easily damaged in handling.

The chief nitrogenous fertilizers of value to the market gardener are sulphate of ammonia, nitrate of soda, nitro-chalk, nitrate of lime, calcium cyanamide, and nitrate of potash.

Sulphate of Ammonia is the most important nitrogenous fertilizer. It is "safer" to use than nitrate of soda as it is not so rapid in action, and is not so easily washed out of the soil. It contains 20·60 per cent nitrogen. It forms an excellent top-dressing fertilizer, especially when a somewhat sustained action is desired. It uses up a certain amount of lime from the soil, but this can readily be corrected by the customary periodical dressings of lime. It mixes well with sulphate and muriate of potash and with superphosphate so that a balanced fertilizer may be easily made containing all the three main plant nutrients.

Nitrate of Soda is very rapid in action, very soluble and easily washed out of the soil. It tends to make clay soils even more sticky, but it does not depreciate the lime content of the soil. Its chief use is as a top-dressing where quick action is desired. It contains about 15 per cent nitrogen, but is generally a dearer form of nitrogen than sulphate of ammonia, although in comparative trials it gave better results than the latter.

Nitro-chalk is a comparatively new fertilizer that is rapidly gaining in popularity. It contains 15½ per cent nitrogen, and about 48 per cent calcium carbonate. It is a mixture of ammonium nitrate and chalk. It is marketed in a granular form for ease of distribution. It provides nitrogen in two forms in about equal amounts—one acting quickly (nitrate), and the other becoming available more slowly (ammonium). The chalk present corrects any loss of lime from the soil caused by the ammonia interaction. This is excellent applied as a top-dressing.

Calcium Cyanamide is made by a combination of atmospheric nitrogen and calcium carbide. It is toxic or poisonous to plant life when first applied to the land, and therefore it is not suitable for side or top dressing, but can be used as a weed-killer. If it is applied to the land 2 or 3 weeks before sowing or planting crops, it undergoes changes that entirely remove its poisonous properties and convert it into an excellent nitrogenous fertilizer that does not tend to make the soil acid. It contains 20·6 per cent nitrogen plus the equivalent of 60 per cent CaO. It is normally supplied as a black dusty powder, rather unpleasant to use, but a granular form has recently been introduced, and this is much more readily used.

Nitrate of Lime contains 13 per cent nitrogen and is similar in effect to nitrate of soda, excepting that the presence of lime prevents any effects on soil texture. It easily absorbs atmospheric moisture and quickly becomes wet and sticky, and cannot be used in mixtures of manures ; for these reasons it is not very popular.

Phosphatic Fertilizers tend to encourage root development, rapid seedling growth, and early ripening or maturation. They are particularly useful for the Brassicæ, for legumes, for lettuces, and for seedlings of salad crops that are transplanted several times. In addition, it may be emphasized that though the effects of phosphatic manures may not be very demonstrative, they are reflected indirectly through the results shown by the other two components of the balanced dressing.

Superphosphate is the most important phosphatic manure and is obtainable in several grades according to the phosphatic content, viz., 14 per cent P_2O_5 = 30 per cent phosphate of lime, $Ca_3 (PO_4)_2$; 16 per cent P_2O_5 = 35 per cent $Ca_3 (PO_4)_2$; and 18 per cent P_2O_5 = 40 per cent $Ca_3 (PO_4)_2$. It does not make the soil acid, and is not readily washed out in the drainage water, but is quickly fixed in the soil and held in reserve, being slowly and steadily released for plant use. Moreover, it is easily applied and suitable for mixing with sulphate of potash and sulphate of ammonia, and is a common ingredient in factory-made manures.

Superphosphate may be applied in autumn or spring at the rate of 4 to 6 cwt. per acre, or 1½ to 2½ oz. per sq. yd.

Basic Slag contains 9 to 18 per cent P_2O_5 or 40 to 80 per cent citric-soluble phosphoric acid, and 40 to 50 per cent CaO. It can safely be mixed with nitrate of soda, potash salts or calcium cyanamide, but not with sulphate of ammonia. The phosphoric acid is only slowly available, and this manure is not so popular with market gardeners as superphosphate. It is nevertheless a valuable source of phosphate, especially for peas and turnips. Under the Land Fertility Scheme (1937) probably much more of this manure will be used in this country in the next few years.

Basic slag is useless on dry soils and is most suitable for heavy and acid soils. It is best applied in autumn at the rate of 6 to 10 cwt. per acre or 3 to 4 oz. per sq. yd.

Bone manures are valuable sources of phosphates and are discussed under "organic manures" (p. 40).

Potash Fertilizers. Sulphate of potash, muriate (chloride) of potash, kainit and potash salts are all marketed for application as manures.

Sulphate of Potash is the most popular and most suitable form in which to apply potash for vegetable and salad crops. It contains about 50 per cent of pure potash (K_2O), and can be mixed readily with many other fertilizers. It is best applied in the autumn, but is also effective as a spring dressing. It may be used at the rate of 1 to 2 cwt. per acre or ½ to 1 oz. per sq. yd.

Muriate of Potash contains about 45 per cent pure potash, but the chloride constituent often checks plant growth considerably. It has detrimental effects on the quality of potatoes, but both this and potash salts have been used successfully for asparagus, celery, seakale and beetroot.

Kainit is not generally recommended for market-garden crops.

Wood Ashes have been used for fertilizing the land for many years and are of value in improving the soil texture and for providing small amounts of potash and minute amounts of other substances. Average samples contain about 4 per cent potash (K_2O) present as potassium carbonate (alkaline), 3 or 4 per cent lime as CaO, and a little phosphate. The composition varies according to the type of wood burned and the temperature of burning.

Compound and Concentrated Fertilizers. *Compound Manures* are mixtures of fertilizers that together provide the major plant foods, usually in a form easy to apply and store. The plant foods may be present in several states of availability, and the proportion of one nutrient to another may vary according to the purpose for which the mixture was designed. Thus special mixed potato, cabbage and other crop manures are marketed.

Concentrated Fertilizers include a series of compound fertilizers developed in this country by Imperial Chemical Industries, Ltd. They are highly concentrated and contain 40 to 50 per cent of plant foods compared with 15 to 20 per cent in ordinary compound fertilizers. Their concentrated nature is partly due to the production of chemically-combined plant foods such as nitrogen and phosphoric acid in the substance ammonium phosphate. They are in a granular form, and it is claimed that each granule contains the correct proportions of the different nutrients, so that these are distributed through the soil with remarkable uniformity. Moreover, their concentration effects a considerable saving in transport and labour costs, since less manure has to be handled and distributed.

Mixing Manures. Compound manures may be prepared by the grower from standard fertilizers in proportions according to requirements. The mixing of the ingredients must be done thoroughly or the manure may not only lose some of its effectiveness, but may even damage the roots of the plants. The mixing process should be done in a dry shed on a concrete or wooden floor. It is usual to add a "filler" consisting of a drying type of fertilizer such as bone-flour, in order to prevent caking of the material. After mixing it should be stored in a dry place and preferably used within a few days.

Many growers prefer to have the mixing of these manures done by machinery at a factory. The initial cost of the manure is thus raised, but the labour costs for home-mixing are avoided and the mixing is done much more thoroughly.

Most compound fertilizers contain the three major plant nutrients, nitrogen, phosphoric acid and potash, in certain definite proportions according to the purpose for which the manure is designed. These mixtures may be referred to as a 5–10–5 or a 4–8–4 fertilizer. The first figure refers to the percentage of nitrogen (N), the second to the percentage of phosphoric acid (P_2O_5), and the third to the percentage of potash

(K_2O). Thus each 100 lb. of a 5–10–5 mixture would contain 5 lb. of nitrogen, 10 lb. of phosphoric acid and 5 lb. of potash, irrespective of the source of the fertilizing elements. The ratio between these percentages is known as a fertilizer ratio and in this instance would be 1 : 2 : 1. A fertilizer analysis of 4–8–4 has the same ratio of 1 : 2 : 1. Thus in making up compound manures it is necessary to know the percentage of fertilizing elements present in each ingredient.

Evaluation of Manures. The analyses of purchased fertilizers is given in terms and percentages of nitrogen (N), soluble and insoluble phosphoric acid (P_2O_5) and potash (K_2O).

Fertilizers that provide the same plant food constituent are usually compared, on a money basis, by their "unit values"; and similarly, ready-mixed compound fertilizers may be compared with home-mixed fertilizers containing the same percentages of constituents (but transport and mixing costs must be taken into account in relation to the home-mixed material).

The unit value is obtained by dividing the price per ton of the fertilizer by the percentage number stated of the particular fertilizing constituent concerned. In other words, the price is obtained (on a ton basis) of 1 per cent of nitrogen, phosphoric acid or potash, as the case may be.

When assessing the cash value of a purchased compound fertilizer, the unit value for the constituents are usually based on the assumption that standard manures are used, such as sulphate of ammonia, steamed bone flour, superphosphate and sulphate of potash. When the unit value for nitrogen in sulphate of ammonia has been worked out, this figure is multiplied by the percentage number of nitrogen in the declared analysis of the compound manure, thus assessing the value of the nitrogen. The figures for phosphates and potash are dealt with similarly. When these figures are added together the total represents the money value per ton of the mixture, to which must be added the cost of mixing and bagging (usually about £1 per ton).

Example: Declared analysis— 4 per cent Nitrogen
6 per cent Soluble phosphoric acid
2 per cent Insoluble phosphoric acid
4 per cent Potash.

Assuming the source of nitrogen in the mixture to be sulphate of ammonia costing, say, £7 10*s.* per ton, and containing about 20 per cent nitrogen, the unit value of nitrogen will be £7 10*s.* divided by 20 = 7*s.* 6*d.*

Similarly the soluble phosphoric acid may be supplied by superphosphate having 16 per cent phosphoric acid, and costing, say, £3 6*s.* per ton, and the unit value will be £3 6*s.* divided by 16 which equals 4*s.* 1½*d.*

The insoluble phosphoric acid may be from steamed bone flour (28 per cent P_2O_5) at, say, £5 5*s.* per ton, and the potash from sulphate of potash (48 per cent K_2O) at, say, £9 10*s.* per ton, giving unit values for insol. phosphoric acid and potash of 3*s.* 9*d.* and 4*s.* respectively. When these unit values are multiplied by the percentage number in the declared analysis the following figures are obtained:—

	£	*s.*	*d.*
4 per cent N at 7*s.* 6*d.*	1	10	0
6 per cent Sol. P_2O_5 at 4*s.* 1½*d.*	1	4	9
2 per cent Insol. P_2O_5 at 3*s.* 9*d.*		7	6
4 per cent K_2O at 4*s.*		16	0
	£3	18	3

Hence the manure is valued at £3 18*s.* 3*d.* per ton, plus the cost of mixing and bagging and an allowance for profit. The method of calculation is not strictly scientific and is purely arbitrary, but nevertheless it provides a practical and simple method of assessing the money value of manures for the purpose of comparison.

Chapter Four

Irrigation

Plants may be watered by means of the watering-can or hose-pipe (with or without a rose attachment), by overhead spraying pipe-lines, by surface watering using porous pipes or open trenches, or by underground method. Intensive salad growing necessitates the use of some form of irrigation, and overhead irrigation is the type in general use.

Overhead Irrigation. Methods of watering so that the water falls on to the soil in a manner similar to rain have been practised in this country for a very long period. Owing to several drought seasons experienced since 1933, both growers and manufacturers have given considerable attention to irrigation, with the result that greatly improved methods and apparatus have been evolved, and the practice has become well known and widely used in horticulture.

An efficient overhead plant may be used to supply water for

(1) Preparing land for seed-sowing or transplanting.

(2) Improving soil conditions for growing crops.

(3) Improving atmospheric conditions, e.g. by the production of a mist-like spray using high pressure, during hot weather.

(4) Facilitating crop harvesting, e.g. watering carrots thoroughly before pulling them.

The importance of water to plant life cannot be too strongly emphasized. The nutrients in the soil must be in solution before the plant can absorb them, and water is also necessary for the transport of food materials throughout the system of the plant. Even the loss of water through the leaves of the plant is important since it helps to keep the plant cool, preventing scorching and death of the leaves during very hot weather. Vegetable and salad crops contain at least 80 per cent of water, and if these crops are unable to receive adequate supplies of water they grow hard and fibrous instead of succulent and crisp. For the production of first-quality salads the necessity for irrigation is found on almost all types of soil, but particularly on the light sandy loams preferred for these crops.

It should be remembered that irrigation is of great value not only to the growing crop but also for preparing land for seed-sowing or for planting young plants. Frequently, transplanting or seed-sowing is seriously delayed owing to the dry state of the soil, and this means that valuable land lies idle while waiting for rains, and the crop is late in maturing. With irrigation installed the grower is to some extent independent of drought conditions, and can take full advantage of warm weather to induce rapid seed germination and plant growth.

We have, however, only a limited knowledge of irrigation as applied to conditions in this country, and such knowledge as we possess is almost entirely due to the enterprise of a few prominent vegetable and flower growers and to certain engineering firms who have specialized on the subject in collaboration with the growers. Notable amongst these growers is Mr. F. A. Secrett, whose patient experimental work and shrewd observation and interpretation of results has made him the leading authority on this subject in this country; and who has so generously given of his knowledge to the horticultural industry in this and in other problems of vegetable and salad production. There is a definite need for research on problems such as the effect of irrigation on the chemical and physical state of the soil, and on its effect on different soils, on the question of feeding plants through their leaves by means of irrigation water charged with plant nutrients, and on the influence of irrigation on the incidence of plant pests and diseases.

Many observers believe that irrigation tends to make soils more acid, and this might possibly be largely brought about by the extra loss of calcium carbonate from the soil in the drainage water. Lime or chalk may be applied to correct this acidity. Finger-and-Toe (*Plasmodiophora brassicæ*) disease of cabbage crops is said to be encouraged by irrigation, and this is associated with acid soil conditions.

Some growers believe that irrigation tends to wash out some of the lesser plant foods. It seems very probable that the loss of nitrogen compounds in the drainage water is increased by irrigation, especially since the adequate supply of moisture enables the bacteria responsible for the release of nitrogenous plant foods to work and multiply consistently. Further, the increased activity of the bacteria results in a greater loss of organic matter from the soil. Thus it is usual to apply organic manures, such as hoof and horn, fish and meat meals, after irrigating, in order to maintain the humus content of the soil and supply additional nitrogenous foods.

It has been found by experience that land absorbs water more uniformly and effectively if it is irrigated before ploughing and not vice-versa.* The subsoiler should be used with the plough and the work must be done as soon as the land is fit to be worked after irrigating. Even better results are obtained if a dressing of straw or farmyard manure is spread on the surface of the soil before irrigating and ploughing. If the weather is warm and dry, on sandy, well-drained soils, a light wooden roller may follow immediately after the plough, the horse walking in the furrow to avoid making hoof-marks in the top soil. A top dressing of hoof and horn or fish meal, dried blood or soot may usefully be applied afterwards and the land harrowed and cross-harrowed to produce a fine tilth.

Water Supply. The quantity of water required will obviously depend on the area of land to be irrigated at one time, but generally between 1,000 and 2,000 gallons per hour should be available to water one acre of land at one time. About 1,866 gallons per hour, per acre, watering continuously for 12 hours, are required to produce the equivalent of one inch of rain.† The water should be free from toxic substances and available in constant and ample quantities.

Main water is often very suitable for small-scale installations, but the Company's charges for supplies and the regulations laid down regarding main pipes, etc., make this an expensive source of supply when required for irrigating large areas. Ponds or streams, when available, may form a cheap source of water providing they are free from contamination. Wells are usually excellent sources of water, and sometimes existing wells, sunk to obtain water for glasshouses, may be utilized for irrigation. The initial cost of the well depends upon the depth at which sufficient water can be obtained and upon any technical difficulties that may arise. If the land overlies water-bearing gravel, as often occurs in river valleys, then ample supplies of good water may frequently be obtained at depths of 20 ft. or less, using very little pumping power. Deep wells have to be sunk in some instances up to 300 ft. depth or more.

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* Secrett, F. A., *Sci. Hort.*, 1935, p. 3.

† Data kindly supplied by Messrs. British Overhead Irrigation Co., Ltd., Shepperton-on-Thames.

For irrigation purposes, shallow, cottage or "curb" wells are seldom of any use, for their yield is frequently small, and, while meeting the domestic needs of a few persons, they may dry up just when big yields are needed for irrigation. Hence, where a spring, lake or river is not available, a bore-hole is most often the proper kind of well to adopt.

It is quite impossible to give accurate figures for the cost of wells, since the conditions vary enormously. Before a price can be given the following factors must be reviewed by the water engineers:

Amount of water required at one time.*

Geological nature of the substrata.

Tip of substrata.

Judgment of the most likely water-bearing geological zone under the site.

Position, altitude, area and distance from site of outcrop of this zone.

Rainfall on outcrop area and porosity of the zone.

Water level at site (judged by levels in other wells, river levels on outcrop, etc.).

Estimated yielding quality of strata (deciding size of hole and depth of strata to be pierced).

Practical difficulties in sinking the bore.

Estimated amount of steel casing tube required.

Haulage and supervision expenses according to the locality.

At the time of writing (1938), unlined bore-wells may cost per ft. 5*s.* to 20*s.* in chalk; 10*s.* to 30*s.* in clay; and up to 40*s.* in rock. Where a steel lining is necessary, bore-holes of between 4 and 8 in. diameter may cost an additional 5*s.* to 15*s.* per ft.

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* Data and figures kindly supplied by Messrs. Guthrie, Allsebrook and Co., Water Supply Engineers, Reading.

Whatever the source of water supply, a pressure of at least 30 lb. per sq. in. at the commencement of each spraying line is essential, and it is advantageous to have available pressure up to 80 lb. per sq. in. The pressures obtained from existing overhead tanks, such as are often erected for glasshouse supplies at about 20 to 30 ft. above the ground level, are insufficient for irrigation purposes. In such instances it is advisable to fit an alternative by-pass arrangement so that water may be pumped direct to the mains when required. It is false economy to use small-diameter mains as much pressure can be lost in this way. It is always well worth while to consult specialists in water engineering on the source and means of obtaining and distributing the water supply. Pumps may be driven by petrol or Diesel engines or by electric motors. Where several sources of water are available a portable petrol engine can be transported from place to place and thus effect economy in main installation. The Diesel engine is more expensive to purchase but cheaper in running costs. Electric pumps are excellent, particularly for small plants and when the cost of current supply is low.

General Lay-out of Spraying Apparatus. The most popular form of irrigation is by means of portable overhead spraying pipe-lines. These are erected across the land and can usually irrigate a strip of approximately 25 ft. width on either side of the spray line. Care in planning the lay-out of mains, sub-mains and stand-pipes, is time well spent, as the spray-lines can then be moved and reconnected with the minimum expenditure of time and trouble.

A suitable arrangement with the types commonly used at present is as follows:

The mains are laid out with the first sub-main branch at a distance of 200 or 300 ft. from the beginning of the area to be irrigated and subsequent sub-mains at intervals of 400 to 600 ft., these distances being dependent on the length of spray-line to be used (i.e. 200 or 300 ft.). Each sub-main should have standpipes or valves at intervals of 45 ft., with the last one at about 20 ft. from the end of the ground to be covered. Thus pipe-lines, connected by 10-ft. lengths of 1¼ or 1½-in. internal diameter hose-pipe to these standpipes, can irrigate the whole area by spraying approximately 25 ft. on either side of the lines. If the standpipes are further apart, longer connecting

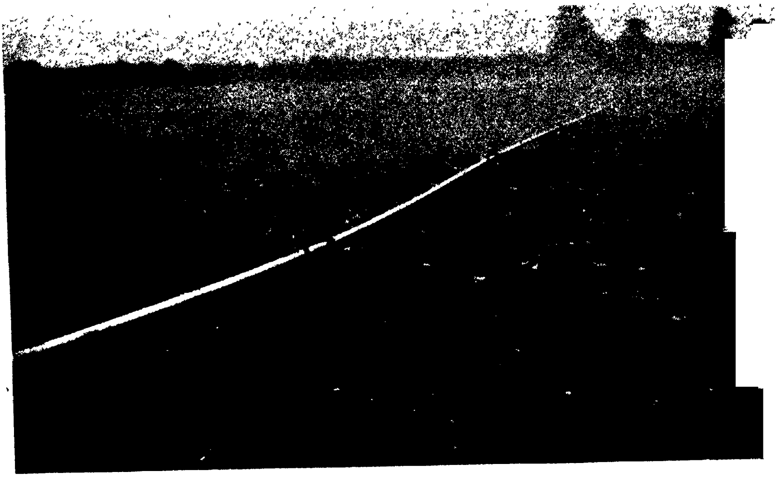
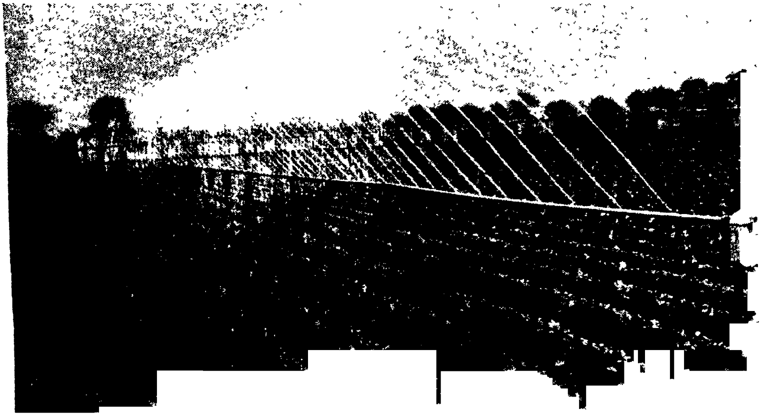


Fig. 1.—OVERHEAD IRRIGATION. Portable "staggered" multi-nozzle spray-line in use for watering land before cropping.

Fig. 2.—OVERHEAD IRRIGATION. Portable spray-lines with "oscillating" attachment by means of which the water spray is automatically rotated from side to side of the pipe-line.



hoses must be used, but this is not advisable. It is a wise practice to erect shelter fences or to plant hedges alongside the mains and sub-mains if these traverse cultivated land, in order to prevent implements and carts from running over the pipes, with consequent breakages. The portable spray lines are supported on movable stands of various types, but the more rigid kinds are the best, especially when oscillating lines are used and irrigation has made the land soft.

Spray-lines can be fitted with automatic flushing valves attached to the last length of pipe, so that grit, etc., may be washed through to avoid clogging the nozzles and surplus water drained away. For this purpose, however, easily removable end caps are more satisfactory and less apt to cause trouble. When not in use the spray-lines should be turned so that the nozzles point downwards and drain away surplus water.

Types of Irrigating Apparatus. The main types of spray-lines are:

(1) Plain single nozzle-line pipes fitted with nozzles in one straight row, usually at about 2 ft. apart. The first length of pipe in the line is fitted with an "arm" by means of which the direction of the spray can be altered from one side to another by hand.

(2) "Staggered" multi-nozzle pipes may be fitted, with from 5 to 7 rows of nozzles arranged spirally around part of the pipe, so that water is applied to a width of up to 40 ft. from one position or "setting". They are most useful for watering land before ploughing, as a greater volume of water can be applied in a given time than with the single nozzle-row type (see Fig. 1).

(3) An oscillator can be fitted to most types of spray-lines, having the effect of continually altering the direction of the spray. The apparatus is fitted at the stand-pipe end of the pipe-line and is operated by the pressure of the water. When in use the spray of water moves or oscillates slowly from side to side, so that both sides of the line are watered. Consequently the water is applied in a manner closely approaching rainfall, as consecutive drops do not fall on the same spot, and while the spray is moving to the other side the water has the opportunity to soak in, thus avoiding flooding with possible damage to soil texture and tilth (see Fig. 2).

(4) Circular sprayers like the French Arroseur Automatique have been in use for many years. The French type consists of a single length of pipe-line attached at the middle to a support on which axis it pivots and revolves, so watering a circular area. Several small British patent types are on the market; they cover fairly large circles by means of a projected jet or jets of water revolving on an axis. They are commonly used for tennis lawns, etc.

(5) Water-squares are chiefly used for irrigating lawns or small gardens where the apparatus may be placed on the path, as they are not well suited for use on cultivated land. The pipes may be of any length from 15 to 100 ft. in length, and can irrigate a width of about 25 ft. each side of the pipe. They are usually supported and moved from place to place on swivelling ball carriages.

Water-fans are only of use on very small areas, and consist of a pipe about 15 in., long, on which several nozzles are set. The pipe oscillates from side to side and waters a rectangular plot of land.

(6) Permanent spray-lines may be fixed at a height that allows of ploughing and other work beneath. The initial outlay is considerably greater than when portable units are used, for sufficient pipes must be purchased to cover the whole area, since the pipes cannot be moved from place to place. On the other hand, a saving is effected in working costs, since there is no dismantling, moving and re-erecting to be done.

(7) With semi-portable spray-lines the pipes are themselves portable but the supports are fixed in position permanently or at any rate for the duration of the current season. The spray-lines can thus be interchanged from one set of fixed supports to another. Portable supports are sometimes a source of trouble since they are apt to sink or tilt over when the land becomes very wet during irrigation.

Feeding Through the Leaves. The possibility of adding plant nutrients in dilute proportion to the water used for irrigation has been investigated particularly by Mr. F. A. Secrett, in co-operation with a firm of water engineers (see *Scientific Horticulture*, 1935, III, 82).

By this means it appears possible not only to apply a top dressing of fertilizers in a liquid form to the soil, but also to feed the plants through their leaves. This theory has some support from the work of Dr. Wallace of Long Ashton in spraying fruit-trees with weak solutions of potassium salts to correct deficiency disorders. In the experiments conducted by Mr. Secrett dilutions of from 1 in 3,000 to 1 in 10,000 parts were found to be suitable.

An apparatus called a "solutionizer" was designed to inject the solution into the main water supply before leaving the pumping house. The solutionized water must be applied in the form of a "mist" spray, produced by the use of very fine nozzles and high pressures, and, according to the workers mentioned, "aerated" water is preferred. There is need for scientific research on this matter, conducted under controlled conditions not often possible for a busy commercial grower. Future developments may even result in the use of overhead spray-lines as a means of applying solutions to control plant diseases and pests.

Chapter Five

Construction and Erection of Lights and Frames

The main purpose of frames is to protect plants from the effects of wind and excessive rains, and to induce and maintain an atmospheric and soil temperature higher than that of the surroundings. At the same time the maximum amount of light must be available for the plants—particularly salad crops. Facilities must also be available for ventilation, and easy access when necessary.

The Lights. The glazed light is more efficient than any other, since glass admits the maximum possible amount of daylight. Moreover, glass permits the heat rays of the sun to pass through into the frames and thus the temperature of both soil and atmosphere within the frame may be considerably higher than that of the surroundings.

The Standard English Light. This is usually made of yellow deal painted with several coats of white lead paint, and consists of a framework, the outside measurements of which are usually 6 ft. by 4 ft. The top rail is usually 3 in. wide and the bottom rail 3½ in. wide. The sides or styles are about 2½ by 3 in. in width. The frame is glazed, with rows of panes of glass held in position by cross-bars about 1 in. wide. The glass panes are obtainable in several standard sizes, viz., 18 by 12 in., 16 by 12 in., 14 by 10 in., 11 by 8 in., and 10 by 8 in. Generally speaking, the larger sizes are preferable, as there is less obstruction to light. The thickness and grade of the glass is indicated by the weight per sq. ft. British Horticultural Glass is usually

21 oz. per sq. ft., and is considered to be superior to foreign glass although the latter is generally 24 oz. per sq. ft.

The panes are bedded in putty into the sides and crossbars and overlap one another about ⅜ in. like roofing tiles, so that rain-water runs off the light freely and does not leak into the frame. The lights are often strengthened by one or two T-iron bars fixed across the light, and these tend to increase the length of life of the light and permit the use of narrower rails, thus lessening the restriction to daylight. An iron handle is fixed at the centre of the top rail and sometimes on the lower rail also, for convenience in handling the lights. The lights must be periodically cleaned, repaired if necessary and repainted. It is a good practice to scrub down the lights before storing when not in use, with a solution of 1 per cent cresylic acid and soft soap, making a special effort to clean off moss, etc., which often appears between the overlapping panes of glass, reducing the amount of light passing through into the frames and providing a possible harbour for pests and diseases.

The French Light. This type is very similar to the English pattern, but the size is usually 4 ft. by 4 ft. 5 in., or 4 ft. 2 in. by 4 ft. 2 in. The outside framework is made of wood, but the inner rails, of which there may be two, three, or four, are of iron. When three such bars are used the panes of glass are 10 by 13 in., and are embedded in putty with a slight overlap as with the English light.

The Dutch Light. The Dutch light is becoming increasingly popular in many sections of horticulture, and for the production of early salad produce in this country it is undoubtedly superior to the English and French types. In appearance not unlike a picture frame, each light consists of a single pane of 21-oz. glass measuring 56 by 28¾ in., which is held in a light wooden framework, the outside measurements of which are approximately 59 by 31¾ in. (150 by 80 cm.). The framework is usually made of deal (*Pinus sylvestris*), but recently western red cedar (*Thuja plicata*) has proved suitable, and although this is more expensive than deal it is durable and, it is claimed, needs no painting. The sides or styles are 2 by 2 in. and the ends or rails approximately 2½ by 1¾ in.; the joints may be nailed or mortised and tenoned.

Cement-coated or galvanized nails must be used with cedar-wood and are preferable for use with other woods. It is important that well-seasoned, knot-free wood be used, or considerable losses may accrue from warping of the wood, resulting in badly fitting lights and sometimes in broken glass. The framework and glass are usually despatched separately by the manufacturers, but the operation of glazing is very simple. The framework should first receive a coat of priming and at least two coats of good white lead paint (this is not essential for cedar-wood lights). As an alternative the lights may be treated with a reliable wood preservative and afterwards painted white to assist light reflection. When thoroughly dry the frames may be loaded with the glass. Grooves are provided in the sides of the framework into which a sheet of glass is slid carefully from the base. A small wooden stop block is nailed on to the bottom rail to keep the glass in place. This stop may be used as a handle. Putty is not required, and it will be found that in a well-made light the glass does not fit perfectly tightly but that a small amount of "play" is allowed so that expansion of the glass under varying temperatures does not lead to breakages through buckling. A ring or handle may be fixed to the top rail.

Compared with other types the Dutch pattern lights offer the following advantages:

(1) The maximum of daylight is allowed to pass through into the frame, since there are no cross-bars, putty or overlapping glass panes to form shade as with the French and English lights. In producing early salad crops, such as lettuces, the most difficult factor is the shortage of daylight in this country during the early months of the year, and therefore maximum efficiency in this respect is very important.

(2) The Dutch light is easily handled and of light weight. One man can easily move a light from place to place, although it is usual for two men to work together carrying two or three lights at a time.

(3) The initial cost is less than that of the older types (frequently half their cost).

(4) It is easily and quickly repaired and repainted, which lessens the cost of upkeep. This is an important point, as it is quite easy to spend half a day repairing and repainting an old English light.

(5) In the Dutch light little or no drip occurs from condensation or leaks. Condensation water runs down the large sheet of glass to the base of the frame.

(6) Convenience in handling makes the Dutch light very adaptable for other purposes, such as glasshouse construction, temporary protection, etc.

Dutch lights have certain disadvantages:

(1) If carelessly handled and broken the whole pane of glass has to be replaced, and at the time of writing this costs approximately 2*s.* 6*d.* Breakages may also occur from faulty wood swelling and warping, and from gale damage. The English and French types of lights are cheaper to repair in such sense, since they consist of several small panes of glass. With reasonable care this should not be a serious disadvantage.

Selection of good wood, adequate painting, care in handling and the provision of methods to secure the light firmly to the frame during windy weather, should prevent these losses.

(2) Being lightly built the Dutch light may not have as long a life as the English and French types. This, however, remains to be proved.

Other Types of Lights. Many ideas on the construction of new types of lights and frames have been patented. With some of these steel or galvanized iron has been substituted for wood with the object of achieving greater durability. Others have removable glass panes or collapsible frames, with ease of construction and dismantling as the main objective. Most of these have so far appealed more to the amateur than to the commercial grower.

Special Glass. In recent years experiments have been made with special glass that permits the ultra-violet rays of the spectrum to pass through on to the crops beneath. While these experiments have improved crop production in some instances, in others, crops grown under ordinary glass were equally as good.

Glass Substitutes. Since glass is so easily broken, several less fragile substitutes have been invented and placed on the market. They are all apparently less efficient than glass in permitting the passage of light. Waterproofed cloth or muslin is used on frames for providing temporary protection for certain crops. Oiled paper and paper impregnated with paraffin have been successfully used in Germany and France in place of glass for certain crops. Another substitute consists of transparent gelatine-like substance fused on to wire netting. Experiments investigated by the author appear to show that none of these glass substitutes can be recommended for production of early salad crops, although they have proved very useful for certain other horticultural crops.

Methods of Securing Lights. The following simple and perhaps obvious methods have proved successful, though the grower will probably be able to devise other methods of his own.

(*a*) *Securing Lights when on the Frames.*

(1) Strong 4-in. nails are driven into the backs of the frames at about 6 in. below the point where each pair of lights fit together. A rope is then firmly secured to the frame at one end of the range and then passed tightly alternately through the handles or rings on the light and then under the nails in the frame itself, finally making fast the rope at the other end of the range. Alternatively one or two lengths of rope may be stretched tightly on top of the glass lights from one end of the range to the other and secured at both ends.

(2) A staple is driven into the light at the back below the handle and another one at the front. Wire or iron hooks are fixed to the frame beneath each staple. The hooks are connected to the staples when high winds are expected.

(3) An iron peg bent at right angles at one end is thrust into the soil against the side of the frame. The bent end is passed through the handle or ring on the light during windy weather.

(*b*) *Securing Stacks of Lights.*

Breakages may also occur during rough weather when the lights are stacked in piles when not in immediate use. These stacks should not be too high, preferably consisting of not more than twenty-four lights each. To make secure against wind a length of wire or rope may be passed over the top of the stack and secured tightly to the handles of a light near to the bottom of the pile. Alternatively strips of batten wood may be used. The battens are nailed to the top light and to a middle and lower light in each pile.

Frames. The frames that support the lights may be constructed to take from one to a hundred or more lights each. They may be permanent structures built of brick or concrete; movable wooden structures that can be dismantled and re-erected on fresh ground periodically; or very temporary skeleton frames for protecting a crop for a short time only.

Permanent Frames. The three most important types of permanent frames are the separate single frames, the double light or span-roofed frame, and the lean-to frame built against the wall of a glasshouse or other building.

Walls of brick or concrete are made for the sides, front and back of the separate frames. The lights are supported by T angle-irons, which are better for this purpose than wood, resting across the frame from the back to the front wall and cemented into the top of the brickwork. With the lean-to type the cross-bars are cemented into the existing wall and on to the front brickwork of the frame. Permanent frames are often heated, as an existing hot-water supply system can usually be adapted for the purpose. Their solid construction and permanent nature make them well suited for both air and soil heating. The soil in these frames should be sterilized periodically (see Chapter Twelve) or alternatively replaced by a good compost of loam, etc. This is not quite so necessary when a system of crop rotation is practised. It is advisable to scrub down the walls and "runners" of the frames annually with a solution of 1 per cent cresylic acid, soft soap and water to provide clean growing conditions and to destroy pests and diseases likely to be present.

It will be found that many existing permanent frames have been designed for tall-growing crops such as pot-plants. If these are to be used for salad cropping it will usually be necessary to raise the level of the soil in the frame to within approximately 5 in. of the light at the front and 8 in. at the back, as most salad crops need to be near the light.

Forcing Pits. These are permanent structures set below the soil level, and thus being protected against wind, provide a more equitable temperature than ordinary frames. The light rests on the pit at ground level. They are provided with bottom heat obtained from fermenting manure, hot-water pipes in the soil or in troughs, or electrically-heated cables (see Chapter Six). They are particularly useful for forcing crops that require complete or partial darkness.

Box Frames. These may be purchased ready made and painted, from horticultural dealers, or they may be built by the grower himself. The latter commonly uses unplaned wood and merely nails the joints together.

A box can be made to take one, two, three or four lights.

It is usually constructed of 1-in. boards, the back board being 11 or 12 in. deep and the front board 8 to 10 in. deep. These boards tend to rot at the base where they are in contact with the soil. Some economy may be effected by using boards 2 in. shallower and fixing a length of 2-in. battening at the bottom, which may be replaced at comparatively small cost when decayed.

Alternatively, two boards each of half the required depth may be fixed together. Certain wood preservatives may also be employed.

The size of the frame depends on the dimensions of the lights used. Where possible it is wise to use only one standard-size light, so that the lights may be changed from frame to frame as required.

The corners are supported by triangular oak pegs and the lights rest on cross-bars or "runners" 2½ in. in width and fixed to the front and back boards.

A portable box frame is now on the market that can readily be taken to pieces. The corner pegs are rectangular and are fixed to the side boards. These pegs have long nails or bolts which pass through holes in the front or back boards. When through the board the nails are bent over and secured by an iron pin, or if bolts are used they are fastened by means of nuts. Iron cross-bars are used and these fit into slots in the back and front boards. Such frames may be easily extended.

Double-span box frames can also be purchased, and a useful structure can be made by hinging pairs of Dutch lights together to form a simple span frame.

Dutch Light Ranges. These ranges, when complete, may be described as long box frames, each of which accommodates 10 to 100 lights, fitting closely together without any rails on which to slide or rest.

The commercial grower constructs these with his own labour, and they are essentially a "mass-production" type of frame, being inexpensive yet efficient.

Single-span Type (see Fig. 3). Using the single-span method and allowing 2-ft. pathways, about 2,500 lights occupy an acre of land, and at the time of writing the approximate cost of lights and timber (excluding labour) is 5*s*. to 6*s*. per light.

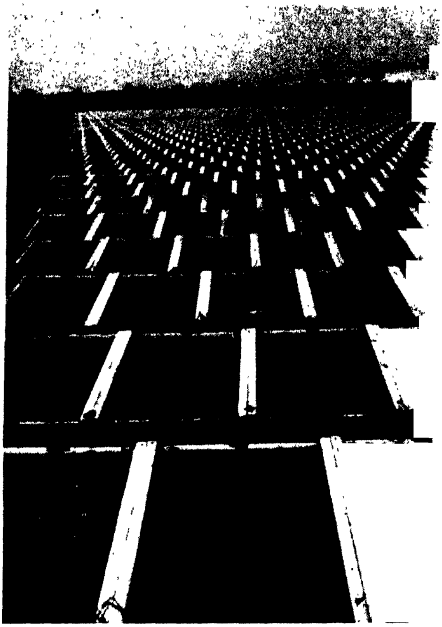
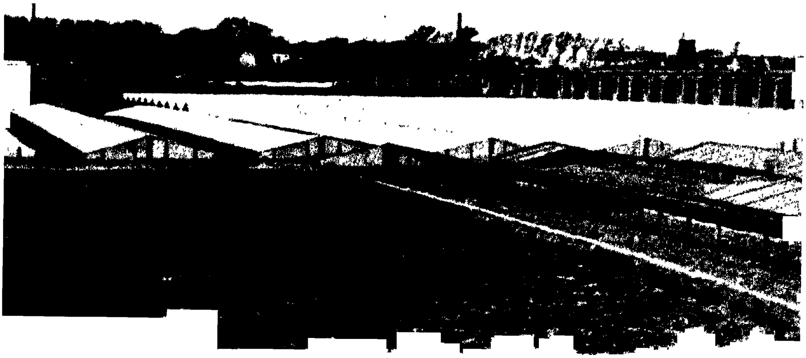


Fig. 3.—SINGLE-SPAN FRAMES using Dutch lights: The "squares" visible through the glass have been marked out to facilitate spacing lettuce plants.

Fig. 4.—DOUBLE-SPAN FRAMES using Dutch lights The framework construction may be seen at the right hand foreground—Dutch light glasshouses or Warenhuize are visible on the right towards the back.



The single-span ranges consist of unplaned red deal or western red cedar, 9 by 1 in. at the back and 4½ by 1 in. at the front. Quartering, 4½ by 2 in., is sometimes preferred for the front boards, as warping is less likely to occur. When quartering is used it is advisable to buy material of which the top surface has been bevelled or planed at an angle so that when the light is placed on it, a perfect fit is obtained. The boards are nailed to 2 by 2 in. deal stakes which are driven into the ground, so that they will be outside the frame when completed, at a distance of 10 to 14 ft. apart. It is not usually necessary to nail the front boards when quartering is used, as they may be held sufficiently firmly by means of pairs of wooden slats, approximately 3 by 12 by ½ in., driven into the ground so that the timber rests between them. The ends of the frames or ranges are boarded with timber 1 in. thick, or with "weather-boarding", allowing the wood to project above the back and front boards so as to prevent the end light from sliding sideways.

Methods of Erection. The site having been chosen and the soil well and suitably prepared, the land is first divided into strips 5 ft. wide for the frames, separated by pathways 18 to 24 in. wide. These strips run east to west. The soil is then cast up from these pathways on to the 5-ft. strips so that these become raised beds. Most of the soil is thrown on to the back (i.e. usually the north side) of the range, so that when raked subsequently the whole bed slopes towards the south. Being thus raised and sloping to the south, the beds are considerably drier and warmer than flat beds.

The back (north) side of these beds is made moderately firm to prevent collapse of the bed and should be about 6 to 8 in. above the soil in the pathway. A line is tightly stretched along the back of the frame bed and then 2 by 2 in. deal stakes are driven firmly into the ground on top of the raised beds at a distance of approximately 10 ft. apart. The back boards (9 in. deep by 1 in. thick) are nailed securely to the stakes, using if necessary a spirit-level and "straight-edge" to keep all the boards level at the top. Some growers prefer to drive the supporting stakes at an angle into the ground, so that when the back boards are fixed in position they slope slightly inwards at the top towards the frame beds. The object of this is to obtain a closer fitting between the back board and the light when in position.

The first front or bottom board is next erected together with one end of the range. Care must be taken to fix the front boards so that they are the correct distance from the back boards, and parallel to them, and also at right angles to the ends. The easiest way to do this is to use a standard Dutch light as a gauge. A strip of wood 3 in. deep and ½ in. thick is fixed along the edge of the back of the gauge light, so that it projects downwards slightly. The worker stands at the foot of the frame and places the light so that the top rests on the back board and the attached piece of wood fits along closely against the back, preventing the light from slipping down into the frame. The front board is then laid in position so that the gauge light overlaps it about ½ in. At the same time the side of the frame is fitted at right angles to the back and front boards and flush with the gauge light. The lights are placed so as to overlap the bottom board slightly, in order that water on the lights may be thrown off into the pathway and not into the frames.

When the first front board is laid in position and the corresponding end is boarded up correctly, the remaining front boards can be erected quite easily, using the gauge light as a check. The opposite end of the frame is then boarded up. No cross rails or runners are fitted—the lights being placed on the frame so as to rest on the back and front boards fitting closely together. It is often advisable, however, to insert a few cross-bars from the back to the front boards in order to reduce the possibility of warping. Finally, more soil is taken from the pathways and banked up with a spade against the bottom of the boards so as to exclude all draughts completely. If this is done when the soil is reasonably moist a neat and lasting job may be done.

The frame beds may then be prepared for the crops by cultivating and manuring as desired. The lights are usually conveyed to the frame-yard and stacked at the ends of the ranges ready to be placed on the frames when required.

For early salad cropping it is usual to place a heavy dressing of straw or litter in the pathways between the ranges. This conserves moisture, keeps the frames a little warmer, and facilitates walking in the pathways in wet weather. At the end of the cropping season the material is dug or ploughed into the soil and thus increases fertility.

Double-span Frames or Ranges (see Fig. 4). In general the construction of these frames is similar to that described for single-span or single-light frames. Double-span frames are erected over beds approximately 8 ft. wide (depending on the pitch of the light) and the beds should run north to south (not east to west as with single-light frames). A wooden bar 4 by 4 in. in cross-section or quartering 4 by 2½ in. is laid on the edges of the bed to form the support for the bottom of the lights. Posts about 3 by 2 in. are driven into the centre of the bed so as to stand about 18 or 24 in. above the level of the soil and at 6 ft. apart. Along these posts a wooden rail 4 by 1 in. is laid and nailed securely, forming the centre of the span to support the tops of the lights. These lights should be made secure at the top by attaching an ordinary curtain-ring to the top rail of each light and linking each pair with wire or cord.

The single-span frame is the most popular type in this country for the production of early salad crops, but the Dutch growers favour the double-span type. Double-span frames are more suitable for temporary protection of crops, and for crops that need a plentiful supply of air and not too close an atmosphere. They are particularly suitable for tall crops, but others can be successfully grown if varieties are carefully chosen. The cost of erection for wood and labour is less for the double-span type than for the single-light, and rather less ground is used for pathways. On the other hand, compared with the single-span frame, the double-span frame is more exposed to wind, and therefore likely to have a lower air temperature and to be most subject to gale breakages. Also, the soil frequently appears to dry out readily; they are not convenient to work, as access to the centre of the bed is not easy; and the lights are not as conveniently removed.

The double-span frame is commonly used by the Dutch "settlers" in Yorkshire, some of whom construct them so that the bottoms of the lights rest on the ground or on turves.

Temporary Protecting Frames. The erection of structures to support lights for temporary crop protection is often well worth while. The Dutch light is the most suitable type, since it is convenient to handle and of light weight. Lights may thus often be kept in use in between times when they are not required for the main crops. Strong posts are driven into the ground to support rails on which the lights are rested. The plants beneath may be further protected by partly closing the sides with hessian. Flower crops (e.g. tulips) are often protected and forwarded in this way.

Accessories. "Stops" are used to prevent the lights from sliding off the frames, especially when these are erected at a steep angle to obtain maximum sunshine.

For temporary frames a wooden peg 2 to 2½ ft. long may be driven into the ground against the bottom board of the frame so that it projects a few inches above the middle of the bottom rail of the light.

An L-shaped iron rod about 10 in. long is sometimes used for Dutch lights—the long arm of the L being thrust into the soil. Iron pegs are apt to loosen easily in the soil.

Permanent frames may have a block of wood or iron nailed to the bottom board of the frame, fixed so as to prevent the light from sliding off.

Ventilating Blocks. Wooden wedges, blocks or pegs are necessary requisites for regulating the ventilation of frames. A useful size is 8 or 10 in. long by 3 in. wide, and 2 or 3 in. thick according to the weight of the light. A useful peg may be made in the shape of an L. The long arm of the L is 12 in. long and 2½ in. wide at the top, while the short arm is 5 in. long and 6 in. deep. The wood may be 1 or 2 in. thick. Lights may be kept open at several positions with these blocks according to requirements. Many growers find it worth while to tie each block to the frame below its respective light, so that it does not become mislaid or trodden into the pathway when not in use.

Props. These are used to prop up lights while the worker is attending to the crops beneath, and are particularly useful when the man has to work alone.

They may be made of strong wood or iron about 4 ft. long and sometimes are used in conjunction with a canvas covering to shelter the worker and the plants from rain while the light is open.

Light Coverings. These are necessary to protect the plants in the frames against severe frost or hot sunshine (newly-sown seeds, etc.).

Mats made of straw or reeds may be purchased ready-made, and last about five years if carefully treated. Canvas or hessian rolls are often used instead of mats and are quite effective against moderate frosts. These can also be used for other purposes (e.g. to form the side of temporary frames). Straw or litter thrown on to the lights loosely, with or without the canvas, makes an excellent protection against even severe frosts. The chief disadvantage to straw or litter is the ease with which it may be blown off in windy weather. It can be held down by wire netting, but this increases material and labour costs. It is often necessary to use boards or ropes to secure mats, etc., against wind.

Other Equipment. Besides the accessories mentioned above the early salad producer will of course require much other equipment. This would include tools, packing materials and containers, watering-cans and hose-pipes, pots, handcarts, wheelbarrows, etc. If the business is sufficiently large a good irrigation plant and possibly a light railway and a soil sterilizer should be available.

Timber Preservatives. Attempts have been made to treat various timbers with chemicals as a preservative against decay. Experiments made by Mr. J. Bryan of Forest Products Research Laboratory, Princes Risborough, have shown that zinc chloride and various proprietary preparations containing sodium fluoride and sodium dinitrophenate are suitable for the purpose. Zinc chloride is dissolved in water to make a 2 per cent solution, which is applied to the wood and allowed to soak in. The speed at which these preservatives can be applied by dipping processes, and their great penetrating and lasting qualities, probably outweigh the disadvantage of their high initial cost.

Creosote is in common use as a wood preservative but is not recommended for any part of the frames, excepting possibly the supporting stakes when these are fixed outside the frames. Crops grown in creosoted frames have frequently failed entirely owing to the toxic effect of the fumes permeating the atmosphere of the frame, particularly during hot sunshine or when artificial heat is applied.

Chapter Six

Soil Warming

Frame beds provided with bottom heat are useful for raising seedlings to be planted elsewhere, or for growing crops to maturity. The heat may be provided by means of hot-beds made of animal manure with or without tree-leaves, by hot-water or steam pipes, or by electricity.

Whatever method is adopted, the site for the frames should be well chosen so that the maximum benefit may be obtained. It should be sheltered from cold winds and gales and situated near to a good water supply. A south aspect should be selected and well-drained land is essential.

It should also be noted that high temperatures are of little use for crop development unless coupled with adequate light.

As a warning to the over-enthusiastic, it should be observed that market prices are very uncertain and variable, so that produce marketed three weeks in advance of the normal does not necessarily command higher prices.

Manure Hot-beds* (see Fig. 10). Horse manure is the most suitable material for this purpose and it should be uniform in texture and composition, and contain a good proportion of urine-soaked litter. Fresh manure may be mixed with half its bulk of manure that has been stacked for some weeks, or alternatively with tree-leaves. The heat provided by such hot-beds is steadier and more lasting than that obtained from hot-beds made entirely of fresh manure.

The fresh manure should be stacked in a compact heap on arrival, and a few days afterwards, when steam is being freely produced, the heap should be turned. This is carried out by making it into a new heap alongside, placing the outside layers into the middle of the new heap, mixing thoroughly and breaking up any hard lumps. The new heap should be made reasonably compact, and the process should be repeated twice or three times at intervals of a few days. In the process of turning, the noxious gases are eliminated; the straw or litter present loses its toughness; and eventually the material smells reasonably "sweet". Sometimes as many as six turnings are necessary before this condition is attained.

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* See also Chapter Seven on French Gardening.

If the heating is very rapid and intense, it may be necessary to add water to the heap to prevent burning. Watering is also necessary if the material is very dry. When fermentation or heating is slow the addition of a little poultry manure when turning the heap is sometimes helpful. Normally, in about a fortnight the material should be uniformly warm throughout and of the right consistency. The hot-beds may then be made up. For frames the beds should extend a foot beyond the area of the frame. They should be made compact by beating with the back of the fork as the work proceeds and finally further consolidated by treading. The part outside the frame should preferably be mixed with alternate forkfuls of fresh manure to provide more heat. The thickness of the bed depends upon the time of year at which it is laid down and the purpose for which it is required. For salads and early vegetables the final depth of the manure should be about 15 in. when made in December, decreasing as the season advances to 9 in. in March. When cucumbers or melons are grown greater depths are necessary.

In French gardening the mixing of "old" and fresh manure takes place entirely when making the hot-bed.

When the bed is finished it should be covered with 4 to 6 in. of soil containing plenty of humus, the frame placed in position and the lights put on. A soil thermometer is thrust into the manure and after a few days, when the temperature begins to fall, sowing or planting may begin.

It is advantageous to bank up the sides of the frame with manure or soil to conserve heat. The lights must be covered with mats or straw during cold and frosty weather. Later in the season, when the beds begin to cool, additional hot manure may be placed around the frame to maintain heat. If higher temperatures are required at this time the old material outside the frame may be removed and replaced with fresh manure. Finally, it should be mentioned that besides the increasing shortage of manure, hot-beds made from this material have certain disadvantages. The temperature obtained is difficult to regulate and gradually falls off; and eventually the manure bed has to be remade, involving further expense.

On the other hand, there is little doubt that the quality of certain salads and vegetables produced on manure hot-beds excels that obtained by any other method. Also, no other medium, excepting possibly electricity, can provide such an equal and uniform distribution of heat over the whole bed.

Hot-water and Steam Pipes.

(*a*) *Hot-water Pipes in Water Troughs.**

This method is in use for forcing asparagus and seakale in specially constructed pits. These pits can also be used for lettuce growing, but the expense of installation and upkeep is high. The pits may be made the width of a Dutch light, and 2 to 4 ft. deep with sides lined with concrete. At the bottom of the pit there are two 2-in. hot-water pipes, both of which should be "flows" to assist the maintenance of an even temperature throughout.

The pipes are laid in open troughs 6 in. in width and containing water. The hot-water pipes heat the water in the troughs and a moist heat is produced. The level of the water is maintained by means of ball-valves.

A moist hot-air chamber is formed by placing a layer of 9-in. earthenware tiles on T-irons about 9 in. above the soil at the bottom of the pit. A layer of long straw is placed on the tiles to prevent the soil in which the crops are to be grown from falling between the tiles. The bed is made by placing about 12 in. of soil on top of the straw.

If the pits are to be installed mainly for lettuce and similar crops that require light, the pit should be shallow, so that when the bed is made up the crops will be growing near the light. Also, it is probable that the temperature and humidity produced would be somewhat excessive for such crops and it is suggested that 1-in. pipes in 3-in. water troughs would be adequate.

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* F. A. Secrett, F.L.S., "Early Market Garden Produce", *Hort. Educ. Assoc. Year Book*, 1933, **II**, 31–42.

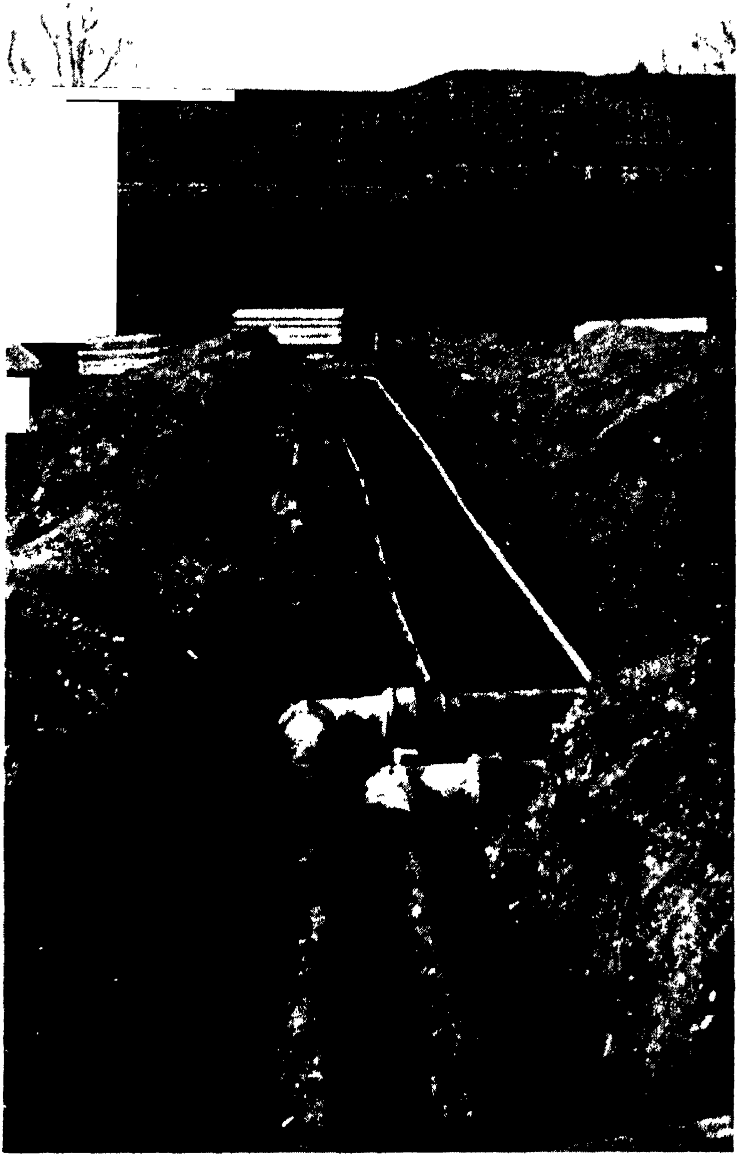

Fig. 5.—SOIL WARMING by hot-water pipes at Oaklands, St. Albans. The 1-in. warming pipes have been laid in position on the site of a range of frames. The 4-in. main supply pipes coming from the boiler are shown in the foreground.

(*b*) *Hot-water Pipes placed directly in the Soil* (see Fig. 5).

The pipes may be of iron, steel or copper. Soil warming by this means has proved valuable for tomatoes in glasshouses under certain conditions (e.g. heavy clay soils). This has been demonstrated by experiments conducted at the Hertfordshire Institute of Agriculture, and at the Cheshunt Experimental and Research Station, at both of which places experiments on soil warming in frames are now being carried out.

The following particulars of experiments at Oaklands were kindly supplied by Mr. E. R. Saltmarsh, N.D.H., Horticultural Superintendent for Hertfordshire.

Tomato Houses. The soil in the houses at Oaklands is of a heavy clay nature, and soil warming has proved effective under these conditions. The apparatus has been in use for five years. The soil is warmed by 1-in. pipes buried 15 in. below the surface and heated by hot water supplied by the ordinary heating system. The water is circulated through the 1-in. pipes by means of a small electric motor. Heat is applied to the soil during the daytime only, so that the efficiency of the air-heating system is not reduced at night. The temperature of the soil at 6 in. depth in the soil-warmed houses is raised 10° F. higher than in the control houses. The fruit matures earlier and the total yield of fruit picked from the soil-warmed houses averages from 4 to 6 tons per acre more than the control houses. Plants grown in the soil-warmed houses appear to be more resistant to Tomato Wilt disease.

Frames. The experiment on soil warming in frames at Oaklands comprises 300 Dutch lights heated by means of 1-in. iron pipes laid at a depth of 15 in. in the soil.

Each range has one flow and one return pipe and heating is provided by a special self-feed magazine type coke boiler. The desired soil temperature is maintained at 6 in. depth by a thermostat that regulates the boiler damper. Temperatures above 60° F. were found to be unnecessary and even harmful to the crops.

During January and February (1937) the soil temperature in the heated frames was consistently 10–12° F. higher than that in the cold frames.

Heating commenced during the first week in December, but this was found to be too early, since normal growth was restricted owing to lack of light. Carrots were sown and planted over with lettuces. Turnips were drilled later and cauliflowers were planted in late February. These were followed by marrows.

Exactly similar crops were grown in the cold frames using the same varieties and sowing on the same dates. The following observations on the crops were made during growth:

Lettuce. These matured earlier in the heated frames and were very uniform. Quality was not improved, and it is possible that some varieties will be found more suitable for these particular growing conditions.

Carrots. These matured quickly but roots were "forked" and of poor colour. The "forking" was attributed to drying-out of the soil.

Turnips. Earlier and larger turnips were produced in the heated frames when light was adequate, but if sown too early the plants ran to seed.

Cauliflowers. This crop derived greatest benefit from soil warming. Cutting commenced in the heated frames 14 days earlier than in cold frames, and the quality was excellent.

Marrows. Some were gathered three weeks before those in the cold frames, probably because any check in growth from cold nights was avoided.

The chief drawbacks to the system are the high cost of installation and maintenance, the localization of the heat, and the tendency towards drying-out of the soil.

If watering has to be done there is a risk of inducing disease in the lettuces. Possibly a method of underground irrigation would overcome the difficulty, though this would increase the cost of installation.

(*c*) *Steam and other Methods.*

At the Alnarp Horticultural Institute, Sweden, experiments on heating the soil by the Sigma system have been tried.

Low-pressure steam is forced through drain-pipes of cement, clay or impregnated wood, having a diameter of about 2½ inches. The pipes are laid on a level keel in U-shaped loops, into the two open ends of which a steam nozzle projects. When the steam is turned on, it acts as an injector and draws in air, so that a mixture of air and steam is forced into the pipes. Immediate condensation of the steam does not take place and the steam and air pass between the joints of the drain-pipes and mix with the soil.*

Experiments have also been made on the use of thin copper pipes laid in gravel beneath the soil of the frame bed, but further tests are necessary.

In another experiment iron hot-water pipes 1 in. in diameter were laid inside ordinary 2-in. drain-pipes, giving fairly successful results.

Electricity (see Figs. 6 and 7).

The application of electrical heating for horticultural purposes has attracted the interest of many growers and scientists in this country and abroad, particularly in Sweden, Norway and the United States of America.

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* J. E. Johansson, "Some Experiments in Soil Heating", *Jour. Min. Agric.*, 1933, **39**, 1113–1116, and "Soil Heating for Early Crops", *Gard. Chron.*, 1932, **91**, 165.

This interest has been aroused because electricity appears to offer possibilities for providing an efficient source of bottom heat, as a substitute for fermenting manure. Moreover, electric heating has certain advantages over other methods of soil warming.

The initial labour incurred in providing bottom heat by electricity is not likely to be repeated for a few years at least; the temperature does not fall off and can be controlled by hand-switching or thermostat within comparatively small limits. With adjustable thermostats the heat can be increased or decreased as desired, to meet varying plant requirements or to counteract sudden low outside temperatures. There are no fumes to injure the plants, and it is convenient, clean and quiet in use and requires very little labour in upkeep. The current may be switched off entirely when not needed, but heat can be provided at full capacity immediately it is required.

The chief disadvantage in this country, at the present time, is the high cost of the current itself, though this may be overcome at some future date following research developments on methods of production and application.

It is sometimes possible to obtain specially low terms for current supply providing it is not used at certain hours when the general demand is at its peak. Unfortunately this often coincides with the period when the temperature out of doors is rapidly falling, and when heat is most needed. Moreover, the necessary measures which have to be taken to prevent loss of heat limit its practical application and the permanent nature of the hot-beds may be a disadvantage in some cropping systems, when the site of the frame-yard is frequently changed.

On the other hand, when really efficient heat insulation of the frame and hot-bed has been provided, the effect of discontinuing the heating for short periods should not be appreciable, since soil is a good retainer of heat.

To sum up, it may be said that electricity has been proved to be an efficient means of providing bottom-heat, but that its application to commercial horticulture is governed by the question of cost.

Costs.

Installation and running costs vary so much in different districts that actual figures are of little use here. At the present time it appears that if electrically-heated hot-beds are to be profitable for commercial salad production, the current supply should not cost more than ½*d.* per unit. In an experiment described by the writer (*) it was estimated that during the time heat was applied 1 unit of electricity was consumed in the production of one lettuce (disregarding the carrots which were also grown in the same frames). The insulation of the frames in this experiment was, however, admittedly inadequate. It has been shown that a fair average consumption for early salad production in frames is 1 unit of electricity per sq. yd. per day.

Soil-warming Cable.

It is possible to warm up the soil by passing an electric current through it directly, but this has serious technical objections.

The usual method is to pass the current through a wire buried in the soil, the resistance causing the wire to heat up and so warm the soil.

When the ordinary mains supply of 220–250 volts A.C. is used, the wire has several coverings selected to exclude moisture and to resist chemical action of the soil, high temperatures and mechanical damage. The cables are manufactured in specific lengths with fixed loadings, two typical examples being a 25-ft. cable loaded at 125 watts and one of 100 ft. for 470 watts.

Salad crops have been successfully grown in this country in frames loaded to 5 watts per sq. ft., but where high temperatures are required, loadings of 7 or 10 watts per sq. ft. are necessary.

Alternatively, a low-tension system may be installed by using a transformer and reducing the voltage from the mains to about 15 volts. In this case comparatively heavy-gauge bare wire may be used, but though this is cheaper and stronger than covered wire the transformer is costly, and this system is not yet in general use in England.

Before undertaking any system of electrical soil warming the grower should consult the cable manufacturers or local electricity company, giving full particulars of temperature requirements and size of frames.

Heat Insulation and Distribution.

The economic application of electricity for soil warming

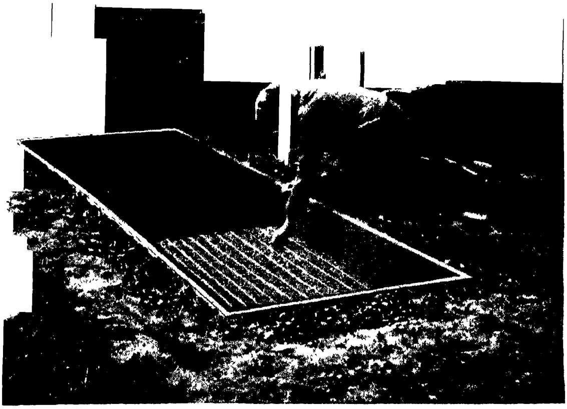
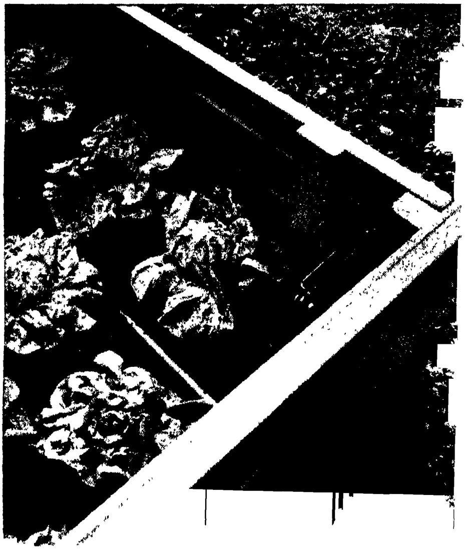


Fig. 6.—SOIL WARMING by electricity, showing cable lay-out and insulation layer around the frame.

Fig. 7.—SOIL WARMING. Lettuces growing in electrically soil-warmed frames. Note connection box and coke insulation layer.



depends largely upon efficient heat distribution and heat insulation or conservation (see Figs. 6 and 7).

Effective heat distribution is obtained by laying the cables in a layer of sand, on which the soil is subsequently placed. The conservation of heat is difficult under average market-garden conditions. To begin with, the site for the frames should be sheltered from cold winds and gales, and it is usually advantageous in any case to erect a low fence to surround the frames. Loss of heat from the bottom of the bed may be checked by excavating the soil and placing a layer of ashes, coke, breeze, clinkers, or broken bricks, at least 6 in. in depth and extending beyond the frame bed by a foot in each direction. This bed should finish flush with the surrounding soil. This insulation layer certainly provides free drainage but may even cause the soil to dry out too readily to the detriment of certain crops, particularly when normal watering is undesirable, though a system of underground irrigation may meet this objection. Further, if at some future date it is desired to remove the hot-beds and plough up the land, the disposal of the insulation material becomes a difficult problem on a large scale. It is suggested that a layer of dry peat or dry straw might provide effective heat insulation for temporary hot-beds. A layer of "dust-dry" peat-moss would probably not become moist throughout, under these conditions, for some considerable time, and should be quite effective during the first few months of the year when the heat is normally required for early salad production. Afterwards the material could be mixed with the soil and serve to increase its humus content. The writer is unaware of any experiments actually carried out using such material for this purpose. The frame itself should be soundly constructed and draught-proof. The boards may be faced with slab-cork or one of the patent insulating boards and the outsides painted with bitumen to protect them from the weather. Alternatively, double sides and ends may be used with the spaces between the boards filled with ashes or similar insulative material. When complete the outside of the frame may be banked up with soil or ashes to conserve further the heat and prevent draught. The lights must be closely fitting and covered with hessian, straw, or mats whenever possible. A double layer of glass may be advantageous, as much heat is lost through the glass itself.

Laying the Cable. After the insulation bed is made and a layer of sand 1 in. deep placed on top, the cable may be laid. It is usually placed in grid fashion, beginning at the short side of the frame or at the end of the range, and laying it in loops backwards and forwards along the length of the frame, bringing the other end back to the starting point. The two ends are later connected to the main switch and fuse which may be fixed inside the frame. The provision of insulated copper wire tails attached to the cables is recommended, as they effectively seal the ends of the heating cable and also keep the heat away from the connection box. As a rule the lengths of cable are laid at about 6 in. apart, but this depends on the amount of heat required. A reserve or an additional source of heat may be obtained by laying similar loops of cable in between these, forming a separate circuit.

A second 1-in. layer of sand is then placed on top of the cable and covered with small-mesh wire netting to minimize mechanical damage when using the spade or trowel.

For general crop production a layer of soil 5 to 8 in. in depth is placed on top of the wire netting and sand, but if a further 2 in. of sand is added instead of the soil, a hot-bed is available for raising seedlings, etc., in boxes.

While simpler methods of hot-bed construction are possible (see reference *), it is obvious that efficient insulation can effect considerable economy in running costs. According to Cameron-Brown (†), tests have demonstrated that, compared with non-

Bewley, W. F.: "Twenty-One Years' Glasshouse Research at Cheshunt", *Sci. Hort.*, 1936, **4**, 114.

—— *Some Experiments on the Heating of Glasshouse Soil by Electricity*, Rep. & Proc. Int. Hort. Cong., London, 1930, p. 414.

† Brown, Cameron: *The Use of Electric Heating Cables for Hot Beds*, Institute for Research in Agricultural Engineering, Univ. Oxon., 1933.

—— —— "Electrical Heating for Horticultural Purposes", *Jour. Min. Agric.*, 1937, **44**, No. 6, 552–61.

Grainer J., and Armstrong, T. F.: "Some Practices of Electric Heating of the Soil and Air", *Gard. Chron.*, June 13 and 20, 1936.

Grove, A.: "Soil Heating by Electricity", *Gard. Chron.*, May 2, 1931.

Jacobsen, G.: *Electrical Heating of Soil in Hotbeds and in the Open*, Rep. & Proc. Int. Hort. Cong., London, 1930, pp. 418–43.

* Quarrell, C. P.: "Electrical Heating of Soil in Frames", *Jour. Min. Agric.*, 1936, **43**, 446.

Taylor, H. V.: "Alternative Systems of Heating Glasshouses", *Jour. Min.* 1934, **41**, 632.

insulated beds, bottom insulation has resulted in a saving of 6 per cent over a period, side insulation in a saving of 25 per cent, and top covering at night in a saving of as much as 26 per cent, in the electricity required to maintain a given temperature.

Temperature Control. This may be effected by hand-switching, time-switching, or thermostat. There is also a self-regulating cable on the market, suitable for small units. Hand-switching is quite satisfactory when carried out properly, the operator being guided by soil-thermometers in the frame and by weather conditions. A time-switch may be set to switch the current on or off at certain times, irrespective of the temperature of the soil or outside atmosphere. A thermostat usually acts on the principle of the expansion of metal due to heat and provides automatic control within limits and is a safeguard against sudden and unexpected falls of temperature outside. A thermostat also ensures a regular temperature which may be beneficial to plants and effects economy by preventing waste of current.

Chapter Seven

French Gardening as Practised in England

French gardening is a highly specialized system of intensive cultivation of vegetable and salad crops. It involves the use of hot-beds made of fermenting manure, and the development of a highly fertile soil very rich in organic matter. The cropping is planned with great care and detail so that many crops are produced in one season on the same piece of land. When this system is carried out efficiently the crops grow rapidly and are of excellent quality, and are generally much earlier than those produced by normal methods.

Historical. As is well known, French gardening has been practised for centuries in the environs of Paris by the French market gardeners, known as "*maraîchères*".

Hot-beds had been in use in the English gardens for some years before the introduction of French gardening to this country. It is recorded by W. E. Bear,* that French gardening in England commenced as a result of a visit to the Paris *maraîchères* by a party of Evesham growers. One of the party, a Mr. Idiens, engaged a French expert while on the tour, and started the first French garden in England near Evesham in March, 1906. The following year, Mr. Fels of Mayland, Essex, commenced a French garden under a French expert and Mr. Thomas Smith. The latter is well known for his standard book on the *Profitable Culture of Vegetables*, which was recently revised by W. E. Shewell Cooper, N.D.H.

It is stated, however, that Huguenot refugees came to England about 1685 and started a French system of gardening in the environs of London (Ministry of Agriculture Bulletin, No. 55).

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* W. E. Bear, *Trans. Highland and Agric. Soc. of Scotland*, 1909, 5th Ser., XXI, 106–122.

In the autumn of 1907 two lady students from Lady Warwick's Garden College at Studley, assisted by a French expert, started a French garden at Thatcham, Berkshire, and others were started shortly afterwards in different parts of the country.

Interest in these new methods soon developed, and in 1908 W. F. Giles, of Messrs. Sutton & Sons, of Reading, read a paper on French gardening to the Alton (Hants) Horticultural Society. The press of the day, however, gave such optimistic and exaggerated reports relative to its possibilities for rapidly acquiring huge fortunes, that the system came into disrepute consequent upon the failure of inexperienced growers. Several growers continued to work the system successfully, but the Great War cut short a good many promising ventures.

Bulletin No. 65 of the Ministry of Agriculture and Fisheries contains an interesting and informative account of the history of intensive market-gardening in England.

Adaptation to English Conditions. The original French gardening methods have been modified and adapted to the conditions in this country by English growers through the exercise of considerable intelligent study, observation and skill. In this chapter an attempt will be made to give a practical account of some of these methods. It should be remembered that although this is broadly outlined as a system of French garden cropping, the whole scheme is flexible, while certain crops are grown in French gardens which do not actually form part of the main cropping system (see latter part of this chapter). The ideas embodied in this intensive cropping system should be of value to market gardeners growing produce by intensive methods, but without a French garden. This is, in fact, already being done, as the intensive cropping system, described in Chapter Eight, under the heading "Dutch Light Gardening", was evolved from a combination of the methods practised by the French and the Dutch growers.

Commencing a French Garden. The following are factors of importance, and while some of them are equally applicable to other forms of intensive work, a certain amount of elaboration and repetition will not be out of place.

(1) *The Availability of Horse Manure*, or some other good substitute. This is probably the most important factor to be considered, for as much as 400 tons of horse manure per acre has frequently been used. As each year more horses are displaced by motor vehicles, the scarcity and high price of good stable manure becomes increasingly marked. Coupled with the decrease in supply is the increase in demand for manure by the expanding glasshouse and mushroom industries. Thus French gardening in this country appears to have but a limited future, unless some efficient and economical substitute for manure hot-beds can be found. Developments on these lines by the use of soil-warming apparatus as a means of creating an artificial hot-bed are discussed in another chapter. The making of "synthetic farmyard manure", or an organic substitute for manure, also offers possibilities, and will be helpful in any event in maintaining the humus content of the soil. However, there are still places to be found where horse manure may be obtained in large quantities, such as those in proximity to riding schools and training stables. Providing other conditions are satisfactory and the supply is likely to be continuous, there appears to be no reason why French gardening should not be carried out with success in such places. It should be remembered that even on good soils a French gardening system can only be gradually introduced, since during the first few years the "terreau" is being built up. Should the grower decide, after some years of French gardening, that the hot-bed system must be abandoned, the land will then be in a highly fertile state, eminently suitable for the production of first-class crops on a cold system, such as Dutch light gardening (see Chapter Eight).

(2) *Training, and Capital Outlay.* French gardening involves a large amount of capital outlay, and demands considerable knowledge, patience and care from the grower. No one should embark upon the full system of production without first undergoing a period of training under an experienced grower. The longer the training the better, but obviously one full season is essential, though not adequate, because of the variation in growing and marketing conditions experienced in different seasons. At the present time the lights and frames for one acre of French garden may cost from £700 to £1,000. The annual running expenses may amount to £350 or £400, estimating the manure account at about £150. When successfully managed, however, the gross returns per acre may be high.

(3) *The Site* should preferably slope slightly to the south, and should not be close to tall buildings or trees likely to cast shade on the land. Moreover, the roots of trees may rob the soil of moisture and plant foods. Protection from the north and north-east is desirable. The foreman's house should be adjoining, or near to, the garden, so that he may be at hand in case of emergency calls (e.g. on unexpected frosty nights).

(4) *The Soil* should be reasonably light and capable of being made highly fertile. Good drainage is essential. If the land has to be drained, the work should be well done and an accurate scale plan made so that the drains may be traced and examined at any future date. Although the French garden soil is practically "made" in time, a heavy clay or dry stony natural soil is not suitable for the work.

(5) *An Adequate Water Supply* for irrigation is essential. The supply may be

obtained from a water company's mains, from streams or rivers, or from a well. Well water is usually most suitable and is cheaper than company's water in the long run, but some growers prefer stream water.

(6) *A Good Supply of Labour* is also essential, particularly if the business is on a large scale and if expansion is proposed. Women are largely employed for much work (e.g. for weeding, thinning, marketing, etc.).

(7) *Transport* is important. In spite of the increase in road transport it is still desirable that the French garden should be near to a railway station that provides convenient daily fast services to the chief markets. Moreover, incoming goods are often sent by rail (e.g. packing crates, manure, etc.).

(8) *Ownership or Lease?* For French gardening, ownership of the land is obviously desirable. Failing that, the grower should obtain a long lease, with adequate provision for compensation on receiving notice to quit.

Planning. The French garden has to be well planned and organized. The usual method adopted at the outset is to divide the area into four main sections, accommodating the hot-bed frame-yard, the cloches or bell-jars, frames for overwintering seedlings, and the open-air section. These sections should be rotated so that eventually hot-beds have been made on each section. The grower will find, however, that each season he will make some modification to the ground plan, and thus no rule-of-thumb methods are possible. All this means a good deal of foresight and careful planning. A packing shed, tool and fertilizer sheds, and space for horse manure must be provided for in the plan. As previously stated, a water supply from one source or another must be installed. The mains and sub-mains should be arranged so that every part of the garden can be watered efficiently. Overhead irrigation is generally practical and a pump will usually be necessary to supply sufficient pressure for the irrigation pipes; unless the supply is obtained direct from company's mains, through 2-in. mains and 1½-in. sub-mains and stop-valves.

General Preparation of the Land. On the whole, arable land that has been well cultivated and manured for some years, and continues to grow healthy crops free from major diseases and pests carried in the soil, is preferable to pasture land. If the latter is used, then precautions must be taken against the usual infestation of wireworms, which frequently cause considerable damage to the crops in the second year after ploughing. Where possible the turf should be removed, and steam-sterilized or baked, then stacked, and eventually returned to the land. It may be more economical to sell the turf as soon as lifted. All the land, with the exception of that reserved for hot-beds, should be bastard trenched or double dug, incorporating manure in the bottom spit. Alternatively, it may be ploughed and subsoiled, and then mechanically cultivated with a roto-tiller or similar machine.

The soil should be analysed at the commencement to give some guide to its general plant-food content and to its structure. This can usually be done free of charge by the Provincial Advisory Officer through the medium of the local County Horticultural Superintendent.

The Hot-bed Section. From midsummer onwards long, green horse manure is collected for the hot-beds and stacked into convenient ridges, 10–15 ft. wide, being ridged like haystacks to throw off the rain. Ventilation shafts are sometimes included in the stacks to prevent overheating. They can be made by packing the manure around baskets set at intervals along the ridges. The baskets should be a little wider at the top than at the bottom, and when the manure reaches the top rim, the basket is raised and stacking continued. An air shaft is thus formed in the finished manure stack. In such ridges little fermentation takes place and the manure retains much of its value.

For making the most efficient hot-beds care should be taken to use only straw manure, and to avoid manure from horses that have been "doctored", or manure that has been drenched with disinfectant in the stables.

Some idea of the quantity of manure required to make the best French garden hot-beds will be obtained by estimating that for one French frame, 13 ft. by 4 ft. 6 in., about one ton of manure will be required. Half of this quantity will consist of fresh manure to be collected in November and December.

Where beech and oak leaves can be obtained cheaply in large quantities, they may be substituted for some of the manure to effect economy. The growing scarcity of manure has led to much experimental work with the object of providing an efficient and economical substitute for hot-bed material as a source of heat. These are discussed in Chapter Six, but it is said that the quality of vegetables and salads produced on manure hot-beds is superior to that obtained on beds heated by other means. This may be associated with the carbon dioxide evolved from the manure, but it has not yet been fully explained.

The "Terreau" or French Garden Soil. In an established French garden the top soil consists mainly of exhausted hot-bed material, which with frequent cultivations, turning and manuring, etc., forms a black spongy material known as "terreau". In this "humus-soil" seeds germinate quickly and give rise to seedlings that have masses of roots to which the terreau adheres when transplanting. Plants grow very quickly in the terreau and produce early, succulent and tender crops. For frame cultivation, hot-beds of manure are made, and the terreau is placed on top, forming an excellent medium for plant growth. When commencing a French garden the natural soil has to be used instead of terreau. The soil should preferably be much enriched by heavy applications of horse manure to previous ordinary crops. If spent mushroom manure, reasonably free from insect pests, can be obtained, this can be screened, dressed with naphthalene and composted with some of the natural soil, to form a substitute for terreau, during the first season.

The Frame Section. *Ridging the "Terreau".*—The soil or "terreau" is thrown up into ridges about mid-November, in order to keep it comparatively warm and to prevent it from becoming sodden by heavy rains. The ridges should be 3 to 4 ft. high and about 10 to 15 ft. apart. They should be far enough apart to allow a cart or other conveyance containing manure to be drawn between them, and should run from north to south.

Before ridging, the soil or terreau is dressed with old soot at the rate of 60 bags per acre, and with 2 cwt. of naphthalene to get rid of soil pests.

When French pattern frames and lights are used one method of procedure is as follows, but if Dutch light ranges are preferred, some slight alterations will be necessary (see Fig. 8).

For French frames the plot is first marked out in strips 13 ft. wide, being the length of a three-light French frame, and of any required length running from north to south. At the north end a strip 6 ft. wide is marked off running east to west. The soil in this strip is dug out and removed to the other end of the plot, making a trench 8 in. deep and 6 ft. wide, and the bottom levelled off. Down the centre of each 13-ft. strip a 4-ft. strip is marked out, i.e. approximately one-third of the total width, corresponding to the centre light of three in a French frame. These 4-ft. central strips are then dug in the ordinary way.

The soil on either side of each central strip is now dug to a depth of about 6 in. and thrown on to it, making rather a flat ridge about 2 ft. high. The soil each side of these ridges is levelled off.

The ridge is now made narrower in width at the base and built up higher and more sharply. To do this, two garden lines are stretched 3 ft. apart down the ridges. A man then treads along the lines to mark their positions and cuts along the marks so made with a sharp spade, thus cutting down the sides of the ridges sharply at the base. The loose soil is then thrown up on to the ridge, making it fairly steep, with a base of 3 ft. and a height of about 3 ft.

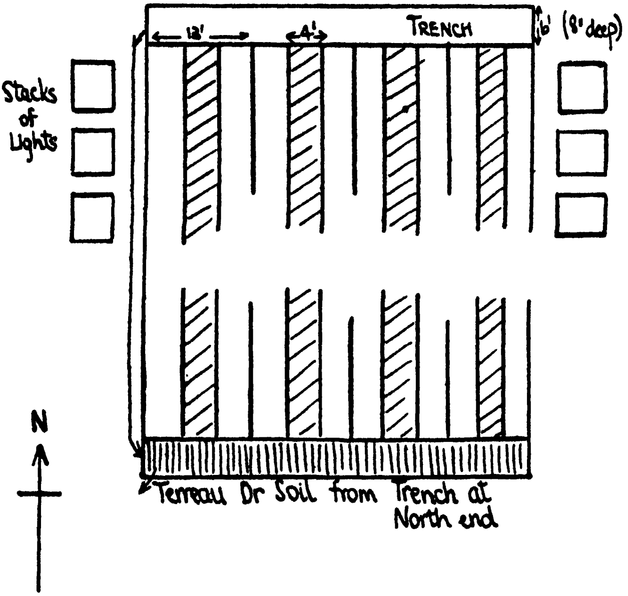

Fig. 8.—FRENCH GARDENING. Diagram of frame plot marked out for frames with first trench opened ready for the hot-beds.

The lights should be stacked conveniently at the sides of the plot in good time, so that work may proceed without delay during favourable weather.

The manure that has been accumulated and stacked during the summer months is now conveyed by light railway, carts or other means, and placed alongside the ridges. Some or all of it is then used to cover the ridges so that the terreau is kept warm, and thus frost cannot hold up the work of making the frame beds. Fresh manure is collected from mid-December to January and placed in heaps between the ridges or in a convenient position alongside the plot. This fresh manure is required for mixing with the old manure (now covering the ridges), as hot-beds made with this mixture are found to be milder and more lasting than if made with fresh manure alone.

Making the Hot-beds and Erecting the Frames. The diagrams given below should help to make clear the successive stages of this work. Work commences at the north end next to the 6-ft. trench (see Fig. 9*a*).

The manure covering the first 6 ft. of each ridge is stripped off and then thrown into the trench to form a rough ridge (see Fig. 9*b*). An equal quantity of fresh hot manure is then brought along and the hot-bed is made by mixing the old and new manures together in alternate forkfuls, shaking out as the work proceeds. The bed must be made uniformly compact and level by treading firmly and by the use of the fork, so that the required depth is obtained (usually 9 in. to 1 ft. when trodden and consolidated). The beds should be about 6 in. wider than the frames.

Terreau is taken from the ridges and thrown on to the hot-beds to form a layer of about 2 in. in depth. The frames are then set in position on the hot-beds, so that they face or slope to the south (see Fig. 9*c*).

More terreau from the sections of the ridges is thrown into the frame, and firmed by treading around the inside edges of the frame, and levelled. The beds are later firmed with wooden pressers or "bats", and again levelled. The total depth of soil or terreau should be 5 in. above the manure. The lights are put on and soil banked up against the base of the frames to exclude draughts (see Fig. 9*d*). Another 6-ft. section of ridge is marked off, stripped of manure, and the next bed is made up as before (see Fig. 9*e*).

The ranges of the frames are erected with pathways 1 ft. wide separating them. These pathways are subsequently filled

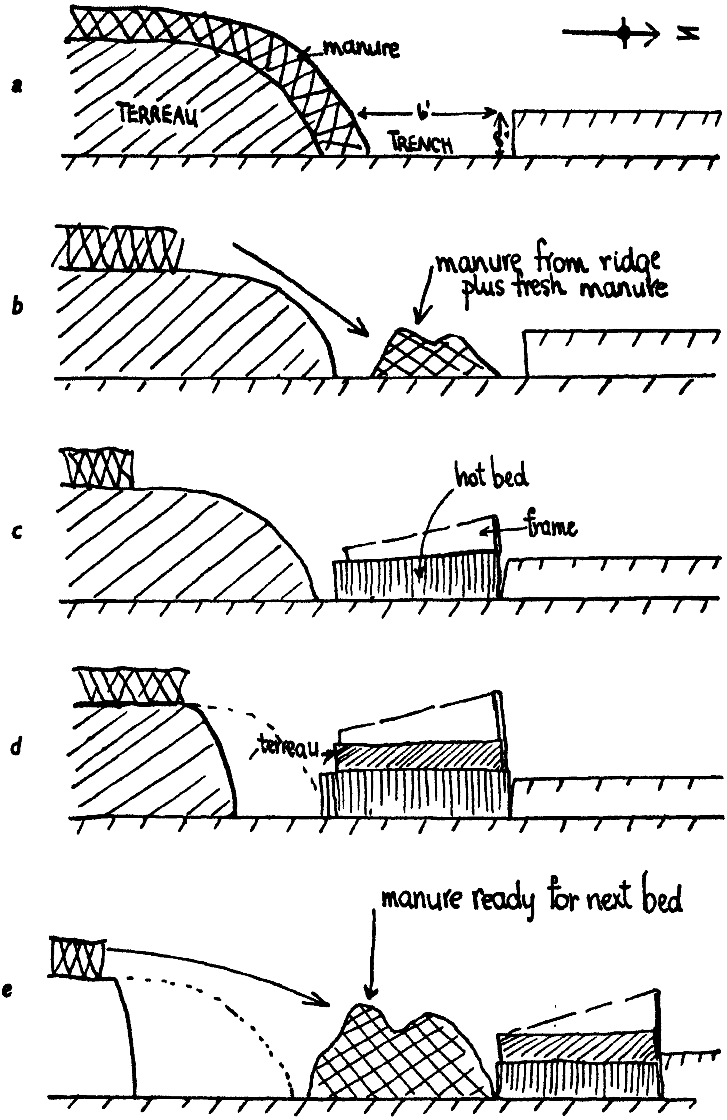
a
manure
TERREAU
6'
TRENCH
1'
b
manure from ridge plus fresh manure
c
hot bed
frame
d
terreau
e
manure ready for next bed

Fig. 9.—FRENCH GARDENING. Process of making hot-beds: Diagrams showing:

(*a*) Trench marked out for frame hot-bed.
(*b*) Fresh manure and manure from end of ridge placed in trench.
(*c*) Hot-bed made and frame erected in position.
(*d*) Terreau from ridge placed on hot-bed and process completed.
(*e*) Manure in trench ready for next hot-bed.

with long straw litter to assist in conserving moisture in the soil and facilitate work amongst the frames during wet weather, when the pathways would otherwise become wet, muddy and slippery. The amount of manure required for the hot-beds is about 1 ton per frame of 13 ft. by 4 ft. 6 in., using half old and half fresh manure. The work continues until the whole site is occupied with the frames, the last row being filled with the terreau taken from the first trench on the site of the first row of frames.

A Simpler Method. This method is less elaborate and considerably cheaper in labour costs than the first. One grower in Hampshire has used this system successfully for many years.

The soil being very light, it is not ridged except in very wet seasons, though this is essential on most soils. Manure is not accumulated during the summer months, but fresh, long manure is collected during December and January and placed conveniently adjacent to the frame plot. It is then watered and turned once to start fermentation and conveyed to the beds by means of a light railway. Subsequent operations are carried out as with ridges, but the terreau is dug out on to the beds "from the flat".

Other methods may be devised by the ingenuity of the grower.

Final Preparation. In all methods the level of the terreau in the frames when finished should be about 6 in. from the top at the back and 4 in. at the front. It is made moderately firm around the inside edges of the frame by treading, then all lumps and rubbish of any kind is removed as the formation of a fine tilth is essential. The main part of the frame beds is made moderately firm before planting by means of wooden pressers. At the present time it does not appear to be sound practice to put down hot-beds in early December to obtain very early lettuces in February or March. Very large quantities of manure have to be used to provide the necessary deep hot-beds, and manure is becoming increasingly scarce. Moreover, such early lettuces have to compete with the larger outdoor type imported from Spain and the south of France, besides the increasing supplies of good lettuces produced from glasshouses in this country. The supplies from these sources diminish towards the end of February, after which frame lettuces are in good demand until the outdoor crops come on to the market. Well-grown English lettuce should hold its own against the Dutch frame lettuce which competes with the home supplies during March and April.

The first beds should therefore be made up round about January 12, for producing, among other crops, lettuces to cut in March and April, followed by those produced in cold frames providing supplies from early April to May.

Raising the Plants. Apart from the collection of manure during the summer months, and any soil cultivations on new land, the French garden year may be said to begin with the sowing of cauliflowers at the end of August or in September.

Cauliflower Plants. Some growers sow out of doors on about August 25, followed by another sowing a week later in case of failure. In the south of England, however, sowings are usually made about September 20, but if the prevailing weather is very mild it is best to defer sowing until the end of the month. Seed should be sown in frames of well-prepared soil at the rate of 1 oz. of seed to a French frame 13 ft. by 4 ft. 4 in. This should give about 4,000 seedlings. The seed is scratched in lightly with a fork, or lightly covered with fine soil. The soil is then firmed with wooden pressers, and the lights are put on. The frames are kept closed until the seeds have germinated, when ventilation to keep the plants sturdy is given as freely as possible on the side away from the wind. When the seed leaves are well developed and the first pair of "true" leaves are showing well, the seedlings are pricked out into other frames. They may be pricked out directly into the frame bed at 3 in. apart or into "small 60's" clay or fibre pots (see Fig. 16). A frame 13 ft. by 4 ft. 4 in. takes about 750 plants. Should the weather prove warm and dry at planting time, in spring, those raised in pots have the advantage, since they commence to grow at once without wilting. Shade should be provided if necessary, after planting out until the plants are established, afterwards giving all the air possible, avoiding draughts and cold winds. The lights may be taken off entirely during mild weather and during warm rains if the soil is dry. The plants should be kept on the dry side, however, as growth must be slow but unchecked. Straw or long manure may be banked against the frames as cold weather comes. The lights must be shut down in very wet or foggy weather and in frosty weather. When severe frosts are expected the lights must be covered with hessian, straw or mats, as 15° F. of frost will get through the glass and freeze the plants, resulting in a large proportion of "buttoned" plants (forming tiny heads) or small second-class cauliflowers. For similar reasons snow should never be allowed to fall on the plants. In November the soil is scratched with a small hand tool between the plants after removing all weeds and dead or discoloured foliage. If the weather is very mild and the plants are forced and too forward in growth, it is often worth while digging up and replanting the seedlings in order to retard their growth.

Varieties: Pioneer, White King, Feltham Forcing, All the Year Round (Four Seasons) and others.

Raising Lettuce Seedlings. In October the most important sowings of the French garden are made, viz., lettuce for cropping in frames and cloches, and for planting out of doors in the spring.

Varieties and dates of sowing are given below, but the grower must discover for himself which dates and varieties suit his particular soil and climatic conditions, and take into consideration the prevailing weather at the time of sowing. In all instances the soil should be, if possible, sufficiently moist to avoid the necessity for watering the seedlings or plants. If the soil is dry it should be watered a few days before sowing or pricking out.

(*a*) *For Cropping in Frames with Hot-beds and Early Cold-beds.* Compact varieties suitable for cropping with carrots, etc., under this system are: Gotte à Forcer, Early French Frame, Blackpool, Early Paris.

Seed should be sown in small successive batches in French cloches or frames on a very finely-prepared seed-bed. The most suitable dates for sowing can only be ascertained by the grower himself under his local conditions, but in one particular French garden in the south of England the following dates have been found suitable: October 8, 10, 12, 14, 18, 20. But if the season is very mild and growth quick, sowings should not be made on the 8th, or possibly on the 10th, or the plants may get overgrown before required. Two later and larger batches should be sown thinly where they can remain to form a reserve of plants in case of loss through diseases such as Mildew or Botrytis among the pricked-out plants.

Quantity of Seed. For a Dutch or French type between ¼ oz. and ⅜ oz. per light will be required, or the same quantity will suffice for nine French cloches. The number of seeds in an ounce varies considerably with different varieties, and the degree of germination may vary also. From actual counts made by the writer 1 oz. of seed gave 15,000 and 20,000 seedlings of varieties such as are recommended for this work.

The seed should be scratched in with a sharp-pronged fork or just covered with fine sifted soil and then gently firmed with a wooden presser. The lights are put on and kept completely closed.

Transplanting the Seedlings. As soon as the cotyledons or seed-leaves are well developed the seedlings are pricked out into other cloches or frames. The frame beds should be slightly raised above the general level of the ground, with a gentle tilt to the south. The site chosen should be open and away from shade of trees, etc. The frames should be well constructed to avoid all draughts, and the lights should fit well to prevent drip as much as possible. The soil for both frames and cloches should be well prepared and a good tilth made. Some growers apply a light dressing of hydrated lime to sweeten the soil. On some soils a light dressing of 1½ oz. per sq. yd. of a mixture consisting of 1 part sulphate of potash to 2 parts superphosphate or steamed bone flour, is beneficial if raked in before pricking out.

The seedlings must be lifted carefully so as not to damage the root system, and care should be taken in handling, as any damage incurred to the stems or leaves may induce disease. As the ground is comparatively soft, the forefinger may be used as a dibber, thus avoiding any damage to the roots which might occur with a wooden dibber. For the frames a marker may be used as described in Chapter Eight, to facilitate spacing. The usual distance is 1½ by 1½ in. apart, but wider spacing 2 by 2 in. is recommended. A French light holds about 500–900 seedlings and a Dutch light about 350–650 according to the system. A French cloche takes about 24–30 seedlings.

The frames and cloches are kept closed until the plants are established and then ventilation is given freely on all favourable occasions so as to produce hard, sturdy plants. On no account should the leaves become wet from rains or fogs or severely frosted. For the earliest batch of forcing varieties (e.g. Gotte types, grown on deep hot-beds), no ventilation is given at all at this stage.

It is necessary to weed through the seedlings in November to December, and the soil between the cloches should be stirred and well aerated. The major seedling diseases are mildew and Botrytis. The localization of plants in small groups under cloches affords better control of these diseases than is possible when they are grown in frames.

The aim is to produce healthy, sturdy, compact plants ready for transplanting to their final positions in frames or cloches from January to February (see Fig. 12). When hardy varieties such as "Imperial" are raised in cloches, the latter may be ventilated by notched pegs. No ventilation is given to forcing varieties.

(*b*) *Lettuces Grown to Maturity under Cloches or Bell-jars.* For this purpose cabbage varieties such as Milly, May Queen, Gotte à Chassis à Graine Noire, Gotte à Coucher à Graine Noire, and Grise à Coucher; and cos varieties such as Lobjoit's Green Cos or Romaine Grise Maraîchère, are suitable. Small batches should be sown on October 12, 16 and 18, to be pricked out into frames and grown on for planting under the cloches when these are cleared of seedlings. For the earliest forcing varieties no ventilation is given at all.

(*c*) *For Late Cold-frame Cropping*, the varieties Milly, May Queen, Grise à Coucher, and Gotte à Forcer, have been found suitable. They are raised in frames similar to those for the earlier beds, but free ventilation to the seedlings is favoured by some growers for all varieties except the "Gotte" types. Successive sowings are made in mid-October.

(*d*) *For Planting and Cropping Out of Doors in Early Spring* the following varieties are suitable: May Queen, Imperial, Improved Trocadero, Feltham King and Winter King. Successive sowings are made in frames from October 10 to 20, and are transplanted into other frames and freely ventilated whenever possible as soon as they are established.

(*e*) *For Cropping under Continuous Cloches*, in late spring, the following varieties are recommended: Feltham King, Sutton's Imperial, May Queen and Milly, and have proved excellent. They are raised similarly to those raised for out-of-door cropping.

Cropping System in Frames. By early January some at least of the frames should have been erected on the hot-beds and the terreau placed on them and then well prepared (see p. 83). The soil should be sufficiently moist to carry the lettuce crop to maturity, without watering. The lights should have been on the frames for four to seven days before the planting begins, and protected against excessive frost if necessary. The first operation is the sowing of the carrot seed. Varieties such as Amsterdam Forcing (*syn.* Primo), Demi-Longue à Forcer, Broadcast (Harrisons'), Xmas Candle, are broadcast in the frame and scratched in lightly with a sharp-tined dung fork. Even sowing can only be achieved with practice. About 2 oz. of carrot seed are required to sow 15 French lights or approximately 25 Dutch lights. If the land is very productive of weeds, the carrots should be sown more thickly (up to 3 oz.), since many seedlings may be pulled up when weeding.

The aim of the sower is to drop the seed ¼ to ¾ in. apart. On no account should the carrot seed be deeply covered. The soil is next firmed with pressers, lightly dusted with hydrated lime, and marked out with the markers as described in Chapter Eight. The carrot seed may be sown as soon as the beds are made up, planting the lettuce six to eight days later after the beds have warmed up.

The young plants are carefully lifted from the other frames or cloches, all damaged or diseased leaves removed, and badly diseased plants rejected. They are planted 9 by 9 in. or 10 by 11 in. apart and "staggered" so that each plant has the maximum amount of space. Planting must be done well, the roots placed straight down in the dibber hole, the tap-root not doubled up, and the roots well firmed at the base; and so that the plants are "sitting" on the soil, being planted neither too deeply nor too shallow. After sowing the carrot seed and planting the lettuce, the lights are put on and kept completely closed except

(1) when weeding or removing diseased leaves or plants;

(2) if the plants were insufficiently protected against frost and the leaves become frozen, a little air is given before the sun shines on the lights: this lessens the damage from frost by preventing a sudden thaw;

(3) if in the spring the lettuce are nearly hearting and the leaves are close to the glass (or on rare occasions before this stage in growth is reached), bright sunshine may scorch them and cause flagging of the plants: a little ventilation for an hour during the hottest period avoids this, but if ventilated too freely the lettuces lose their bright green colour, and moisture is lost from the soil.

After planting up the beds, all pathways between the frames must be filled with straw, litter or long manure, to keep out draughts and conserve moisture, and to prevent puddling of the soil when walking between the frames (see Fig. 10).

In frosty weather the frames must be covered with reed or straw mats or rolls of hessian. Loose straw or litter is often more effective but is likely to be blown off in windy weather. If pieces of straw get inside the frame, they may encourage Botrytis disease. One grower in the Swanley district * makes mats from wire netting folded over to form a kind of container in which long straw is packed. The ends of the netting are secured together with cord or wire, making an "eiderdown" or flat cushion of straw.

Careful weeding of the carrots must be done as soon as these can be handled, taking the opportunity at the same time to remove any diseased leaves from the lettuces. The *early* weeding and thinning in the frames must never be neglected or the resulting tangled growth of weeds and carrots between the fast-spreading lettuce leaves will be difficult to deal with and expensive in labour. Carrots must be thinned so as to stand 1½ to 2½ in. apart.

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* T. Smith, *The Profitable Culture of Vegetables.*

Planting Cauliflowers. When the lettuce are fully grown and beginning to heart, cauliflower plants are taken from the frames in which they have been overwintering (see p. 86). These are planted between the lettuces, clearing a small space among the carrots if necessary and planting three along the top and two along the bottom of a light alternating with two along the top and three along the bottom of the adjacent light. Fig. 21 (*a*).

Another method of spacing cauliflowers and lettuces is illustrated in Fig. 21 (*b*). The planting plan of two adjacent lights is shown and it should be noticed that none of the plants is placed immediately beneath the timber of the lights.

Sowing Turnips. At the same time, in addition to (although this is not recommended) or instead of the cauliflower plants, turnips may be sown between the lettuces, variety Demi-Longue à Forcer (half-long forcing). These are sown by means of a piece of wood or batten, the length of the light, on to which corks are nailed at 4 to 6 in. apart (see Fig. 13). The corks are pressed into the soil between the rows of lettuces so as to make holes about ¾ in. deep. Two or three turnip seeds are then dropped into each hole, and covered with soil, but not firmed. When these seeds germinate they are thinned out, leaving only one strong plant at each site. Shortly afterwards it may be necessary to give a little air to the frames during warm sunny spells by blocking open the lights on the side away from the wind. It may be necessary to lift the frames by means of wire hooks, using bricks to hold them in position, in order to give the cauliflowers more head-room when established and growing freely.

Gathering Lettuce. Early in March the lettuce should be ready to cut. The actual date depends upon the earliness of planting and the weather experienced.

The lettuce are cut and marketed as described in the chapter on Dutch Light Gardening (see p. 117), and as soon as most of them are cleared, the lights are removed temporarily. The beds are then given a thorough watering, using overhead irrigation if possible. Afterwards the beds are weeded and probably watered again. The lights are replaced but ventilated a little at first and more freely as the season advances. Airing is best done with wooden blocks, opening the lights alternately at top and bottom, but if the weather is windy, air on the lee side only.

Growth of the carrots, turnips and/or cauliflowers is now very rapid, and the turnips will be the next crop to be marketed.

Harvesting and Marketing the Turnips. The turnips grow quicker than the carrots and should be pulled when ¾ to 1 in. in diameter and 2 to 4 in. long. They should be ready about the end of April or the first week of May.

They are bunched in twelves neatly so as to present an attractive appearance, and the leaves are left intact (except for the removal of any yellow leaves). They are well washed, sponging if necessary with a piece of wet sacking or a very soft brush. They are packed in non-returnable wooden crates usually holding twelve bunches each.

Gathering and Marketing the Carrots (see Fig. 11). About the second week in May the first carrots should be ready. It is wise to water the beds before pulling as the carrots then lift easily. Pulling commences when some of the carrots are about 2 in. long. They should be put up in bunches of about 1½ lb. in weight and containing 25 to 30 carrots each. The foliage is left on and about 12 to 18 bunches are packed in paper-lined non-returnable wooden crates.

Meanwhile the frames are being freely ventilated, and if the weather is at all favourable the lights may have been removed entirely, as they should be by the time the carrot leaves are 6 in. high (early May) or the tops develop at the expense of the roots. As soon as the carrots are cleared (pulling extends over several weeks), the cauliflowers are hoed freely and overhead irrigation is applied almost daily until the heads are formed. Cauliflowers must not be watered in bright sunshine, as this tends to encourage soft bacterial rot of the heads. As the cauliflowers develop heads, a leaf is broken over the flower to protect it against the effects of bad weather.

Cutting and Marketing the Cauliflowers. The cauliflowers are marketed from the middle to the end of June. They are cut early in the morning with a long sharp knife or special cutting tool. The leaves are "docked" by cutting them off about 2 or 3 in. from the curd or flower. They are packed with the base of the stem outwards in wooden crates holding 18–24 each. (If the remainder of this system is not followed, marrows may be planted in the frames just before the cauliflowers are mature.)

After the cauliflowers are all cut, the lights and frame boxes are cleared and stacked away, or used for growing melons and cucumbers. The black terreau is dug over shallowly and levelled out, filling the pathways.

Second Crop of Lettuce. Lettuce plants (var. Feltham King or Glory of Nantes) may then be planted 9 by 9 in. apart, though this crop is often omitted. The seed for these plants is sown about May 2 in a sheltered border out of doors. Planting out takes place about the end of June.

Celery. At the end of June to mid-July self-blanching celery is planted out, sometimes with lettuces between them. Varieties recommended include Pleine Blanche Doré, Doré Amélioré, Chemin Doré, Clucas' A1, Suttons' Self-blanching and White Plume. Strains and stocks vary considerably in quality (see Fig. 14).

Earlier crops may be obtained by omitting the cauliflower crop and planting immediately after the carrots are cleared. Most seedsmen now treat their celery seed before despatch against the "celery leaf-spot" or "rust" disease, which may be carried by the seed. If the seed has not been treated, it should be steeped for three hours in a solution of one part of 40 per cent formaldehyde in 300 parts of water. After being washed and dried the seed is sown in finely-prepared soil on mild hot-beds in frames, or in boxes placed in the heated glasshouses, about March 10 (earlier sowings may run to seed). Soil is sifted lightly over the seed, gently firmed with pressers, watered with a fine rose, and the frame then covered with lights and mats until the seeds germinate. The seed is very small and needs careful sowing, as if sown too thickly the seedlings are drawn and weakly. A frame 13 ft. by 4 ft. 6 in. requires about 1 oz. of seed and should give about 5,000 to 6,000 seedlings. Germination is often slow, sometimes taking from four to six weeks. As a preventive against "leaf-spot", Bordeaux mixture or "Bouissol" should be applied when the seedlings have developed three or four leaves. The seedlings should be pricked out as soon as they can be handled, generally in May, into other frames at 2 in. apart each way.

The plants are then covered with lights and mats until established, when the mats are removed and air given in increasing quantities, so as to harden off the plants gradually. When hardened off sufficiently the lights are removed altogether, weeds are removed and the plants kept well watered. At this time a further spraying against the "leaf-spot" disease is advisable. Soot is often applied, as it acts as a stimulant and has some deterrent effect on the fly. Nicotine washes are also effective. The celery plants are planted out of doors from the end of June to July 12, between lettuces (var. Feltham King or Glory of Nantes). The latter, if not already in position, may be planted out now at 9 by 9 in. apart, with the celery similarly placed. A planting board about 9 in. wide with nails along the edges at 18 in. apart will be found useful.

The celery plants should be well watered a day before lifting and then placed in boxes, and left in a tub of water for a short time to soak the roots before planting out. The top leaves may be trimmed off and any affected with celery fly or blight removed and burnt. This trimming of the leaves lessens the chance of severe leaf-blight infection by providing more air around the plant. It also reduces the loss of water from the plant through its leaves and therefore assists it to recover from the check of transplanting. Heavy and frequent waterings are essential, and dressings of old soot are applied when the plants are established and again about three weeks later. Preventive sprayings against the leaf disease should again be applied about mid-July and at the end of July. When lettuces are grown as an intercrop, it is better to avoid spraying until these are cleared (usually about mid-July) since deposits of solution may be left on the leaves.

The varieties recommended are self-blanching and grown closely together, but in some seasons blanching may be assisted by packing clean dry straw between the plants about a week before gathering.

Marketing the Celery. The celery is marketed at the end of August or early September, continuing with successive batches until the end of October. It is pulled by hand, the stems or butts are trimmed with a sharp knife and tied in bundles or fans of three to six sticks each. It must all be cleared before frost arrives, as this would render the crop useless for market.

If celery fly has been severe, it is advisable to remove the top few inches of terreau, sterilizing it or mixing with naphthalene, then placing it on the open-air section of the French garden.

All foliage and rubbish should be cleaned off the land.

Turnips as a "Self"-Crop. If all the frames are not required for carrots and lettuces, etc., frames may be set early in February

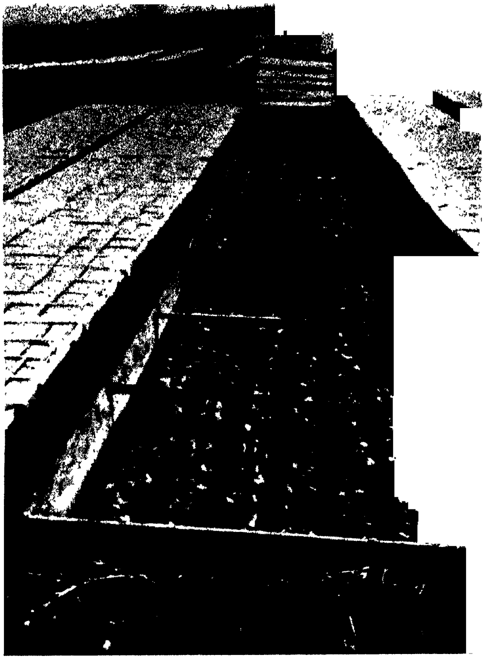


Fig. 10.—FRENCH GARDENING. Lettuce (var. Gotte à Forcer) planted over carrot seeds in hotbed frames. Note straw and litter placed around frames in pathways.

Fig. 11.—FRENCH GARDENING. Pulling, bunching and washing young carrots. A crop of lettuces, grown with the carrots and covered with lights, has been taken from the beds.

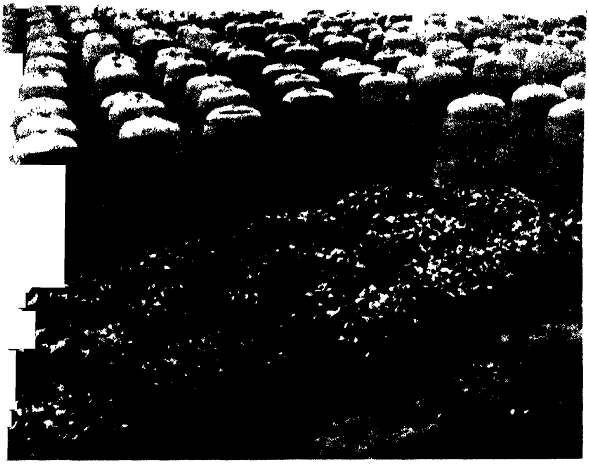
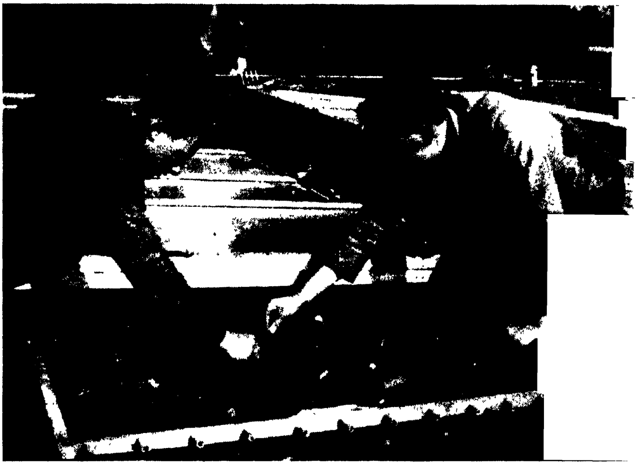


Fig. 12.— FRENCH GARDENING. Seedling lettuces (var. Milly) under cloches ready for transplanting to cropping positions.



g. 13.— SOWING URNIPS (var. emi-Longue à orcer). Note piece f batten wood with orks attached for pacing and making oles for seeds.

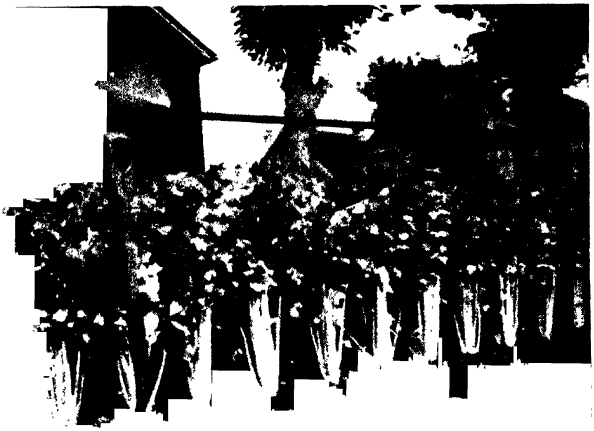


Fig. 14.— CELERY. Self-blanching type growing in a French garden in Hampshire.

and sown with turnips as a self-crop. Varieties such as the French Navet à Forcer Demi-Longue, or Early White Milan, may be used.

Frames and lights may also be available about early April when they are no longer required on the hot-beds for producing carrots and lettuces. Turnips sown in frames in March are easier to produce than earlier sowings, as the latter tend to "run to tops". Also, the demand for very early turnips is only found in London and in some of the large provincial towns.

A depth of at least 5 in. of terreau is necessary for early turnips.

For sowing, a square lattice of batten wood is made, with the battens forming about 5 by 5 in. squares, and fitting exactly into the frame under a light. At the points where the battens cross, corks are nailed. The lattice is placed on the frame bed and the corks are pressed into the soil to make holes about ¾ in. deep and 5 by 5 in. apart. Alternatively a single piece of batten may be used with corks attached (Fig. 13).

Into each hole two or three seeds are dropped and lightly covered with soil, which is then gently firmed. Subsequently the seedlings are thinned to stand singly. The frames must be kept closed at first, but ventilation is given freely as growth proceeds. The lights are removed altogether when the leaves touch the glass. The frames must be hoed and the weeds kept down, and the soil kept moist with frequent waterings. Turnips require about two months to reach marketing stage (i.e. when they are about 4 in. long if long varieties). They are tied in fan-shaped bundles of eight or twelve each with the foliage retained. The bundles are washed and packed in twelves in non-returnable crates. For local trade they are sometimes bunched in sevens in a rosette form, one in the centre and six around.

Cloche Section. *French Cloches.* Bell-jars or bell glasses are shaped like glass bells or domes 14 in. high and 16¾ in. in diameter at the base (see Fig. 12). Their shape allows condensed moisture to run down the glass without dripping on to the plants. They should be obtained without glass knobs on the top, as these are of little use for carrying purposes, and if present, should always be removed or they may act as a lens and scorch the plants growing under them. They may be transported by means of a special one-man wooden carrier consisting of a frame structure on which 4 "nests" of three cloches each can be carried, or one man can easily carry several if he grasps them correctly.

Apart from their use for raising seedling lettuces to be set out in hot-beds in January, these cloches are used for a special cropping system.

At the end of January or early February mild hot-beds are made similar to those made for frames, but the temperature should not be more than 50° F. If horse manure is not available satisfactory hot-beds may be made with rotting leaves.

The hot-beds are covered with 4 to 5 in. of terreau. The beds should be about 5 ft. wide and separated by alleyways 1 to 1½ ft. wide. Each bed takes three rows of cloches arranged alternately or "staggered" and with the cloches about 4 in. apart in the rows. The crops commonly grown under these cloches are lettuces, radishes, carrots and cauliflowers.

Raising Lettuce Seedlings. The lettuce plants are raised from seed sown under cloches on a cool bed about October 25. The seedlings are pricked out at the "seed-leaf" or cotyledon stage under other cloches on a warmer bed.

Cropping Systems. The cloches are usually placed in position on the cropping beds a few days before planting to enable the soil to become warm. They are then removed and radish seed is broadcast very thinly over the whole area and afterwards scratched in with a sharp fork. Alternatively carrot seed may be used, but this is not as satisfactory as radish. The soil is then firmed with wooden pressers and cabbage lettuce planted so that four plants are equally spaced under each cloche. Cos lettuce are planted outside and between the cloches to make six rows per bed.

The first crop to be cleared will be the radishes, which mature about three to four weeks after sowing. The cabbage lettuce are marketed about the end of March, usually six to eight weeks after planting. The cloches are moved twice to cover the cos lettuce. The first cos lettuce mature in about eight to nine weeks after planting, so that two crops are produced and marketed during April and early May. When carrots are grown thus they are usually ready in May.

Note that ventilation is not necessary for most cabbage lettuce varieties, but some air should be given to the cos lettuce by tilting the cloche with a notched stick thrust in the ground, or by pressing down the soil at two opposite points at the base of the cloches.

The plants must be protected against frost by covering the cloche with mats. This is often done every night in spring as a precautionary measure. In late spring during very bright weather the cloches should be shaded with whitewash on the sunny side.

If cauliflowers are grown only three cabbage lettuce are planted under each cloche and one cauliflower plant is placed in the centre of the cloche. Carrots are best omitted in this system. Lettuces (var. Milly or May Queen) are planted first, and when they are established and growing freely, the cauliflower plants (var. Pioneer or White King) are planted. After a day or two, the cloches are ventilated, increasing as the weather becomes warmer, to prevent the cauliflower from forming a premature head or "button".

Another cropping system provides for one cos lettuce plant in the centre and three cabbage lettuces around it under each cloche.

After the crops are cleared the cloches are removed and sometimes used elsewhere for protecting French beans or vegetable marrows. When not in use the cloches should be neatly stacked in threes or fours. If they tend to fit too closely and stick together a small block of wood should be placed at the top of the dome to keep them apart.

After removing the cloches the beds should be cleaned, levelled and well watered, preparatory to planting celery.

Varieties to Use. The following varieties may be mentioned :

Cabbage Lettuce. Gotte à Coucher à Graine Noire is perhaps the most suitable variety for cloches. Others are Gotte à Forcer, Grise à Coucher, Early French Frame, and Milly.

Cos Lettuce. Lobjoit's Green Cos (or Romaine Grise Maraîchère).

Radishes. French Breakfast and Short Top Forcing.

Carrots. Primo (Amsterdam Forcing) and others.

Cauliflower. All the Year Round, Pioneer, White King.

Continuous Cloches may also be used in French gardens, using ordinary soil or terreau (not hot-beds). Cabbage lettuce (var. May Queen, Feltham King and Milly); cos lettuce (var. Lobjoit's Green Cos); and Cauliflower (var. Feltham Forcing and Early London), may be successfully grown under these cloches (Fig. 25).

Cold Frames. Cold frames often form part of the cropping system in a French garden as they assist in maintaining a continuity of supply. Separate crops may be grown in these frames, or a cropping system may be adopted such as described in Chapter Eight on Dutch Light Gardening.

Open-Air Crops. The out-of-door area is rested and manured during the winter. It receives about 80 tons of dung per acre, and dressings of organic fertilizers such as hoof and horn or meat meal are applied. Old manure is preferable as fresh manure is said to lead to Botrytis disease in lettuce. A layer of about 4 in. of terreau is spread on top.

The first of the open-air lettuce crops should be planted up as soon as weather permits at the end of January and early February. The work must be done with all speed so as to provide lettuces to meet the demand at the end of April and early May when the frame lettuce will be finishing and before the bulk of the Dutch supplies arrive usually at the middle or end of May.

The lettuce plants are raised from seed in cold frames in October and later pricked out into other frames where they are grown as hardily as possible throughout the winter (see pp. 87 and 109).

Planting Out. When planting out the lettuces into their final positions a planting board is used, 10 ft. long and 21 in. wide, from both edges of which nails project at a distance of 11 in. apart. The worker stands on the board and plants seedlings against the nails on one side. The board is then turned over and another row of plants inserted as before, these plants being opposite those in the first row. A third row is now planted between these two rows alternating with the plants in these rows so that in the three rows the plants are approximately 11 by 11 in. apart. The board is again turned over and planting continued. Hoeing should be carried out between the plants as soon as they are established and repeated frequently to keep down weeds and to assist in the development of the plants.

These are interplanted with cauliflowers (var. Pioneer, White King, Feltham King or Early London) in early March or even later if the weather is very cold or frosty. Cauliflowers are planted 2 ft. apart in the rows, which come after every second row of lettuce (Fig. 30). Thus the cauliflowers are

24 by 21 in. apart. Deep planting is advisable as the plants grow better and the stems are protected to some extent against frost.

If tomatoes are to be interplanted between the cauliflower shortly before they are ready, the latter should be planted after every third row of lettuce (Fig. 15).

The lettuce should be cleared and marketed as soon as possible so that the cauliflower may be hoed and cultivated. The cauliflower may be dressed with nitrate of soda in mid-April and again in mid-May at the rate of a handful (approximately 2 oz.) to every eight to ten plants, and worked into the soil. Some growers add a small quantity of corrosive sublimate (mercuric chloride) to the nitrate of soda, to help control Cabbage Root Fly and Finger-and-Toe disease.

They should be well watered throughout the growing season but not during hot sunshine when the curds have formed. Cos lettuce 14 in. apart may be intercropped with the cauliflower instead of the cabbage type.

Autumn Cauliflower. Spring varieties such as Pioneer or White King are sown during mid-June, and later planted out at 2 ft. apart in rows 2 ft. 6 in. apart, during mid-July, for cutting in September and October.

Tomatoes Intercropped with Cauliflower. Tomatoes are a somewhat uncertain crop out of doors in this country, but in the South of England good crops are often harvested. Under French garden conditions probably the chances of success are greater than in ordinary gardens (Fig. 15.)

During March a mild hot-bed with a covering of terreau is made in a frame. Tomato seed is sown in this frame at the end of March or early April. The variety Market King is probably the most reliable, but Fillbasket, Carter's Sunrise, and other out-of-door varieties have been grown successfully. The grower should try various sorts to discover which is the most profitable when grown under his particular conditions of soil and climate.

About ¼ oz. of seed per light should be sown at intervals of a few days : 1 oz. of seed gives about 5,000 to 6,000 seedlings. When the third or fourth leaves appear the plants should be pricked out at about 5 in. apart each way, on good soil in a cold frame.

The frames should have been prepared ten days or a fortnight previously, and the lights placed on in order to warm up the soil. Alternatively the seedlings may be pricked out into 60-size clay or fibre pots plunged in soil, at the same spacing as with the first method. Whenever fibre or paper pots are used care must be taken to keep the pots themselves moist, otherwise the plants often receive a check.

The plants need shade until they are established, and then they should be gradually hardened off by increasing ventilation, but protected from frost and very cold winds. If the foliage turns bluish or purplish in colour this usually indicates that the temperature of the air and possibly of the soil is too cold. In the French garden the tomatoes may be planted between the cauliflowers following the previous intercrop of lettuce (see p. 99). The time of planting is early June, when the cauliflowers are nearly mature. They are planted 18 in. apart in the rows, which on this system of intercropping will be about 30 in. apart. Plants from pots become established very quickly, and for this reason are preferable to those pricked out in the frame bed. If a "pot-dibber" or pot hole-cutting implement is used, planting is made much easier and quicker.

The cauliflowers should be marketed and cleared as soon as possible and the beds hoed and cleaned. The tomato plants must then be supported with stakes and all side shoots broken off neatly at their point of origin. They are allowed to grow on until four flower trusses are formed, when they are "stopped" by pinching out the leading growth close to a leaf-stalk. As further side shoots arise they are all removed excepting one at the top, which is shortened as it grows.

A good tomato fertilizer or a mixture of sulphate of potash, dried blood, sulphate of ammonia, and superphosphate in proportion according to the plant's requirements should be applied as a top dressing when the first fruits are formed and swelling, repeating the dressing at intervals of three weeks.

One of the chief diseases of outdoor tomatoes is Potato Blight (*Phytopthora infestans*) and preventive measures should be taken. The plants should not be grown too closely together and never allowed to become too "soft" or "sappy" in growth. The latter can usually be corrected by reducing the water supply and applying sulphate of potash. Routine sprayings with Bordeaux mixture or a colloidal copper preparation should be made. The plants should receive the first spraying while in the cold frames, that is about May. Further sprayings should also be made about the end of July, mid-August and during the early part of September.

In a warm dry season the August spraying should be omitted, but the September application is essential, and for this last application a colloidal spray such as "Bouissol" should be used, as it marks the fruit less than does the Bordeaux mixture.

Some defoliation will probably be necessary to assist free circulation of air and to expose the fruits to sunshine, but this must not be overdone. As much fruit as possible is allowed to ripen on the plants, but when frost is imminent, the remainder must be picked green and stored in trays or on a platform, in frames with the lights put on.

Lettuce for Marketing during Late Summer and Autumn. There is usually a break in the supply of lettuces after the last of the spring-planted crop is finished about early June. The French gardener makes no attempt to produce lettuce during the mid-summer months since the markets are well supplied at that time by the large field growers, and private gardeners are producing their own supplies. Moreover, the heavy supplies of soft fruits, such as strawberries, affect the demand for lettuce. During August, September and October, however, lettuce is again in good demand, especially during hot, dry spells. Growers who produce crops on highly-cultivated soils by French garden or other intensive methods are in a favourable position to supply this demand, since their fertile soil produces quick growth, and droughts are no handicap when overhead irrigation is available. Varieties such as All the Year Round, Feltham King, Suttons' Matchless, Market Favourite and similar varieties are sown at weekly intervals out of doors from the end of May to the end of June, for planting out as the frame beds are cleared of cauliflowers and carrots in the French gardening and Dutch light systems. At this time of the year, however, the best results are often obtained by sowing out of doors in drills 1 ft. apart and later thinning the plants to 9 or 12 in. apart in the rows. Grown in this way the plants are less likely to "run to seed" or "bolt" than when they are transplanted, and they are also less susceptible to mildew. Such sowings should be made in June as the beds or land become available.

Further sowings of varieties such as May Queen and

Improved Trocadero may be drilled in similarly during the first and second weeks in July. The latter sowings are best made in beds the width of the frame, so that they may be protected if necessary against an October frost.

For further successions seed may be sown thinly in frames about mid-August and later planted in frames set out on the beds cleared of early celery in September. These give lettuce ready to cut during October to November. May Queen and Gotte à Forcer should be suitable.

Finally, supplies up to Christmas can be obtained from very thin sowings of the French (Gotte) varieties in frames during early September. These are later planted out in frames on old hot-beds or other good soil. The plants should be transplanted when very small so as to avoid a severe check, which would predispose them to disease. These late lettuces are very subject to mildew and Botrytis, since growth is slow at this time of the year and long spells of damp dull weather are often experienced.

Additional Crops.

Dwarf Beans (*Dwarf French or Kidney*). Varieties such as The Prince, or Masterpiece, should be selected. There are three methods:

(1) Seeds may be sown in 60-size pots and placed in a frame on a mild hot-bed in early March, and later planted out in frames about 12 in. apart each way, the plants being thinned to two per pot at the time of planting.

(2) Alternatively, sowings may be made in pots in cold frames in batches commencing about the middle to the end of March, so that they may be planted in frames and covered with lights taken from the carrot ranges.

(3) Another method is to sow seeds during April in open beds marked out to take frames. They are sown in groups of three seeds about 12 by 12 in. apart, later thinning the seedlings to one or two per station. When the soil is just cracking with the growth of the seedlings, they should be covered with frames and lights from the carrot bed.

Whichever method is adopted, constant hoeing and weeding and frequent watering are necessary. Ventilation is given in increasing quantities, and when the leaves touch the glass of the lights when propped fully open, the latter are removed entirely.

Sowing may be made out of doors from about April 20, in the South of England. The seed may be drilled in rows 2 ft. apart, when about 50 to 60 lb. of seed per acre will be required, or the seed may be dropped by hand at about 1 ft. apart in the rows.

Early- and late-harvested crops are generally in demand, but mid-season (August) supplies are of little value. The latest sowing should be about July 27.

Suitable varieties are Bounteous, Fifty-Days, Sixty-Days, Perpetual and Masterpiece.

Marrows. The varieties Green Bush and Earliest of All are especially recommended, but a good strain of any bush variety is suitable. Two seeds are sown in a large 60-size pot about mid-April and the pots are plunged in a mild hot-bed frame. Marrows may also be raised in glasshouses or in cold frames. They are thinned out later to two or one in a pot.

The beds are prepared out of doors by digging holes 6 by 6 ft. apart and about 1 ft. or more in depth. These holes are filled with manure, and finished off with about 6 in. of soil or terreau. The seedlings are planted out from the pots in early May when the cloches from the lettuce and cauliflower are available. If no cloches are available planting out should be deferred until the end of May. As the plants grow and fill the cloches, increasing ventilation is given, and the plants are hardened off so that the cloches may be removed entirely by the end of the month. The plants must be shaded from the hot sunshine by whitewashing the cloches.

When frames are used, the marrows are planted in mid-April and often form part of the cropping scheme in Dutch light gardening.

Summer cabbage, sown early in March, can be used as an intercrop with the marrows.

The first marrows should be ready to cut in mid-June. They are cut when young and only about 8 in. long. The very early produce is packed in crates lined with hay, six or twelve marrows per crate. As soon as the price becomes very low, with the increasing supply of field-grown marrows, the ground is cleared and prepared for the next crop.

Endive. Endive is usually sown in frames in the French garden from the third week in May and onwards. The seedlings are transplanted out of doors 12 by 12 in. if blanched by tying, or 12 by 18 in. if mats are used to blanch them.

Varieties are Rouen (tender), Ruffec and Moss Curled (more hardy) (see Chapter Eleven).

Radishes. Radishes are a useful catch crop on the outdoor area of the French garden. They are also useful in frames (see Chapter Eleven).

Leeks. Leeks form a useful rotation crop with lettuce, as their deep-rooting habit improves the physical condition of the soil. A variety such as Prizetaker may be sown on heat in January and planted out in March, 4 in. apart in rows 1 ft. apart.

Chapter Eight

Dutch Light Gardening

The phrase "Dutch light Gardening" and other similar terms are commonly used to indicate a special system of intensive cropping of early salad and vegetable crops in frames having Dutch-pattern lights. The system is really a modification of French gardening, hence the term. The essential difference between the two systems lies in the nature of the growing medium. In French gardening, hot-beds are made of fermenting manure, which provides heat and nutriment for the crops in the frames. There is no soil in the usually accepted meaning of the word, but a highly fertile medium called "terreau", consisting mainly of old hot-bed material very rich in decayed and decomposing organic matter of a black crumbly nature.

On the other hand, in Dutch light gardening the natural soil is much enriched with heavy manurial applications resulting in a fairly high content of humus, but still obviously "soil". Hot-beds of fermenting manure are not used in this system, although systems have been evolved for providing bottom heat by means of underground hot-water pipes, or by electric cables. Indeed, an important feature of this system is that these crops can be produced early in the season without the use of expensive methods of providing heat. There is no clear-cut line of demarcation between Dutch and French gardening: Dutch lights are in fact frequently used for French gardening instead of French lights, as well as for several other systems of cropping in frames and glasshouses. While the original pattern of the Dutch light came from Holland, the cropping system has been modified to suit conditions in this country and could now appropriately be termed "English frame gardening".

Most Dutch growers apparently prefer to use their frames for the production of one crop at a time. It is easier to devote the whole frame to one or two crops only and follow with others planted or sown after the first have been cleared. Many beginners would be well advised to commence on such lines, and thus gain a knowledge of the individual crops before launching on the still more intensive methods.

Salad crops are produced in combination with certain vegetables in several systems of intensive cropping in cold frames. One of the most popular systems practised in this country includes the production of lettuce, carrots, cauliflower, and vegetable marrows during one season in the same frames. This system will be described in some detail in this chapter.

Other crops, such as turnips, radishes and French beans, may form additions or alternatives in this system. While these systems may be practised under English and French lights, the superiority of Dutch lights for the purpose cannot be doubted in any country where lack of daylight in the early months of the year may form a limiting factor in salad production (Figs. 3 and 4).

A full description of the construction of Dutch lights, together with a discussion of their advantages and disadvantages as compared with other types, will be found in Chapter Five. In the same chapter are given details of the construction of the frames themselves. The selection of soil and site has already been discussed in Chapter One, but it should be noted that for most successful results in this section of intensive salad production, the soil is very important. A light soil is almost imperative for the production of first-class young carrots, while the humus content of the soil is an important factor in lettuce cultivation. A good water supply is of paramount importance for irrigation of some of the frame crops during the late spring and summer. Much can be done by cultivation and manuring, but if the soil is of the right physical structure half the battle is won. The grower who commences this form of cultivation as an adjunct to his existing market garden will probably have little choice in regard to soil, but must do the best with the land available. His land is probably quite adaptable, but if it is very heavy clay or extremely stony he would be wiser to leave Dutch gardening out of his business. On the other hand, soils that do not reach the ideal standard may be considerably improved by skilful cultivation and manuring, and even by the addition of coarse sand to rather heavy soils, if it can be bought cheaply.

Moreover, the skilful grower will modify and adapt a system to his own conditions, possibly eliminating some crops and substituting them by others more suitable for his soil and climate, or other local circumstances.

It will be remembered that in this system, lettuce, carrots, cauliflowers and marrows form the principal and probably the only crops to be grown.

Sowing Cauliflowers. In order to provide cauliflower plants ready for planting into their final positions at the end of February, the seed must be sown from the last week in August to the end of September. It is wise to make several successive sowings of seed at intervals of a few days, in case the seed-bed fails, and so that all the plants are not ready for transplanting at the same time. A well-prepared seed-bed is made out of doors and the seed sown evenly and thinly in drills. One ounce of seed contains about 14,000 seeds. Seeds may also be sown broadcast in frames during September.

As soon as the seedlings are large enough to handle, they are transplanted into frames, or potted in 60's and the pots placed in the frames. Raised beds are made on which the frames are placed. These are made so that the frames tilt or slope to the south at an angle of about 30 degrees. When transplanted into the frames the plants are dibbled in at 3 by 3 in. or 4 by 4 in. apart, and if necessary watered in. When grown in 3-inch pots better results may be expected, since at the subsequent transplanting into their final positions the plants receive little check in growth. On a small scale the cauliflower plants may be potted up into good loam on the potting bench and then placed closely together in the frames. For large-scale production the frames may be erected as previously mentioned, with a good slope towards the south so that the maximum benefit may be derived from the winter sunshine. The soil in the frame is raked level and if too much is present it is taken out and placed on the pathway in convenient heaps. The base is then raked smooth so that the level of the soil follows the slope of the frame when the light is placed on. Pots, size 60's, are then placed in the frame uniformly level and within ⅛ in.

of one another, but not touching so closely as to cause unevenness (Fig. 16). No drainage material is placed in the pots and the soil is screened or sifted on to them from the heaps in the pathway. These heaps may be previously sifted and the fertility of the soil increased by adding a little bone flour and sulphate of potash (say a 60 pot-full of each per barrow load). Fig. 16 shows the process in operation.

The heaps of sifted soil are then spread over the pots so that they are filled together with the spaces between them. Very gentle pressure with the fingers may be applied to the soil in and around the pots. The plants are taken from the seed-bed during late October and dibbled singly into the pots.

By this means the plants are "potted" into 60-size pots which are "plunged" in soil, and therefore excessive drying-out is largely prevented. Whichever method is adopted the lights are placed on and kept closed until the plants are established, usually a matter of a few days.

It is sometimes recommended that the pots should be moved frequently or placed on cinders in the frame to prevent the plants rooting into the soil beneath. This, however, is not always practical, even though it may be worth while under certain conditions.

As soon as the plants are established, ventilation is given, increasing until the lights are taken off entirely on all favourable occasions. Every endeavour is made to keep the plants growing steadily but very slowly. The plants are therefore grown as hardily as possible without actually causing a check to the plant growth. Lights are placed on whenever frost, snow or heavy rainfall is expected.

It will probably be necessary to cover the frames with straw or mats to prevent frost damage, and if severe frost is experienced when no protection has been given, the damage to the plants may be lessened by ventilating the frames before the sun shines on them and causes a rapid thaw. The plants remain in these frames until the end of February, when they are planted out into their final cropping positions in frames with the lettuce and carrots, or out of doors.

Varieties: Early London, Feltham Forcing, Pioneer, Le Serf, All the Year Round, Presto, White King, and Veursche of Veentjes.

Fig. 15.—TOMATOES (var. Market King) growing out of doors. A crop of cauliflowers has been grown in the spaces between the rows of tomato plants.

Fig. 16.—RAISING CAULIFLOWER PLANTS for cropping in other frames or planting out of doors in early spring (Feb.-Mar.). Screening soil into pots that have been placed in the frames. The soil is afterwards levelled so as to fill the pots evenly and the spaces between them, in readiness for transplanting the cauliflower plants.

Fig. 17.—SEED-BED PREPARATION. A piece wood is being used to complete levelling ar removal of lumps, debris and stones.

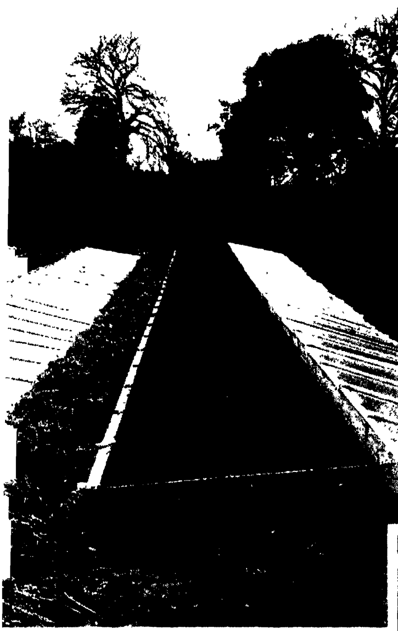


Fig. 18.—A WELL-SOWN SEED-BED OF LETTUCE. The lights have been removed since the weather is favourable. Note ventilation blocks at the foot (left) of frame.

Fig. 19.—PREPARING FRAME BEDS for transplanting lettuce seedlings in their overwintering quarters. Note wooden marker (half-way up the frame) and the planting lines marked out.

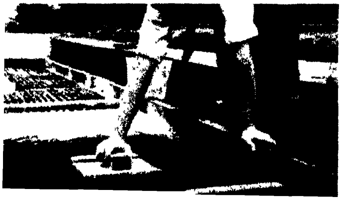


Fig. 20.—DUTCH LIGHT DENING. Lettuce (var. C Forcer) nearly mature with carrots growing between

Raising the Lettuce Seedlings. The choice of varieties is again important. Most of the varieties grown out of doors during summer are useless for cropping in these frames since they fail to "heart" under the poor light conditions of this country during winter and early spring.

Varieties such as the following are preferred for this work: Gotte à Forcer, Grise à Coucher, May Queen (though this tends to grow too large and generally requires more ventilation).

The seedlings may be raised in cold frames by sowing in trays or boxes in a light loamy soil and pricking out the seedlings as soon as the seed-leaves or cotyledons have developed, into other boxes or into a frame. On a large scale the plants are produced by sowing in frames erected on slightly raised beds and pricking out later into other frames. The seed-bed should consist of soil in "good heart" and reasonably free from weeds. It should be thoroughly prepared by raking several times so as to produce a fine tilth, and a "smoothing" board used if necessary (Fig. 17). Seed is broadcast fairly thickly and just covered with fine soil sifted through a ¼-in. riddle. It is usual to sift the soil directly on to the seed. The sower endeavours to drop the seed evenly over the whole surface of the bed. The quantity of seed required to sow under a single Dutch light is approximately ¼ oz., and this should provide approximately 5,000 plants, assuming germination is good and losses are few. Successive sowing should be made at 7-day intervals commencing early in October. It is a mistake to sow too early, as the seedlings may become too forward before planting out into their final positions. The lights are placed on the frame and no air is admitted until the seed has "chitted" or germinated, when ventilation is given gradually at first but later as freely as possible, removing the lights entirely during favourable weather (Fig. 18).

Pricking Out Lettuce Seedlings. As soon as the seed-leaves or cotyledons are developed, the seedlings are pricked out 1½ in. apart each way into other frames or boxes. For this purpose the frames are erected on a slightly raised bed and the soil well prepared by forking and raking with the wooden and iron rake. A good tilth is all-important, and the soil must be of the right degree of moisture. For this reason it is well to commence preparation of the frames well in advance, so that the lights may be placed on to keep the soil from becoming excessively wet, if heavy rains are experienced, and protected from severe frost which might prevent transplanting at the critical time. All large stones and hard lumps of soil are raked off and the whole made level and smooth so that the soil is about 5–6 in. from the light at the back, and about 3–4 in. at the front of the frame. Alternatively a 2-in. layer of fine soil may be sifted or screened into the frame.

A light dressing of terreau is beneficial if lightly raked in, or moist peat-moss might be tried as a substitute, followed by a light dusting with hydrated lime. The soil is then made moderately firm with "pressers" (flat boards about 18 by 12 in. with handles) and the beds marked out for the lettuce seedling rows at 1½ in. apart. An efficient and simple marker can be made with a piece of 2 by ½ in. wood, into which 3-in. nails have been driven at intervals of 1½ or 2 in. The marker should be of a length so as to fit into the frame from top to bottom. Two men then pull the marker along the range, scratching lines 1½ in. apart in the soil along the length of the range (Fig. 19). The seedlings are lifted very carefully, so as not to damage the root system, and only small quantities are held in the hand at one time. They are pricked out into the prepared frame at 1½ by 1½ in. or 2 by 2 in.,* rejecting any that show signs of disease. Pricking out is usually done with the finger, but a dibber may be used. Many growers prefer the use of the finger because it is claimed that the planters are less likely to damage the root system by this method. In any event care must be taken

(1) that the seedlings are in the cotyledon or seed-leaf stage;
(2) not to squeeze the plants (leaves and stems) ;
(3) to plant firmly, especially at the base;
(4) to plant so that the seed-leaves are only just above the level of the soil (neither too shallow nor too deep);
(5) not to allow rain to fall on the seedlings;
(6) not to water the seedlings overhead.

It is wise to cover the whole range with lights before commencing the work and then remove single lights as required. One man works at each end of the light, kneeling on sacks filled with other sacks or paper.

A light is removed, and in order to reach the centre of the beds each planter leans on a board placed across the frame and resting on the adjacent lights. When this section is completely planted the adjoining light is slid along to cover the plants and uncover a fresh section of frame for planting.

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* The wider spacing (2 by 2 in.) is preferable.

The lights are kept closed for a few days until the seedlings are established; then ventilation is given in gradually increasing amounts. The object is to grow the seedlings as hardily as possible. They must never be watered overhead nor exposed to rain or very hard frost. Well-grown plants will stand up to 12° F. frost. Covering the frames when frost is expected and ventilating after frost to prevent rapid thaw will largely prevent damage.

It may be necessary to secure the lights to the frame during rough weather by one or other of the methods described in Chapter Five. Preventive and control measures should be taken against diseases and pests, such as slugs, wireworms, mildew and Botrytis (see Notes on Pests and Diseases).

Site and Preparation of Land for "Cropping Frames". The site should be fairly sheltered with a gentle slope to the south or south-east. The land must be well drained, and preferably in a high state of fertility. Land that has been well cultivated and manured in the past should be chosen, and if crops such as early potatoes or several crops of radishes are first taken off the land, the texture is improved and the weeds reduced.

Work should commence in June or July, by double-digging or ploughing and subsoiling the land. Repeated cultivations are of great value in building up the fertility of the soil and killing weeds. One successful grower prepares the land by ploughing in 80 tons per acre of dung in June, July or August; then at the end of September it is ploughed again, and in October it is ploughed a third time to re-cover the manure.

If the soil is heavy it is worth while to throw it up in ridges running north and south. This facilitates aeration and drying of the soil, and these make such soils warmer and more easily worked. (It is usual to protect these ridges with mats or straw against hard frost a few weeks before the beds are made.) On light soils the ridging may not be necessary, and it is possible to begin erecting the frame beds in November or December. After the land has been allowed to settle, the boards for the frames are erected, generally at the end of November. The lights are not put on until about Christmas week in order that the winter rains may be absorbed as reserve in the soil.

On a large scale it is probably cheaper to plough in the manure before any frames are erected; but some growers prefer to dig in the manure directly into the frame beds after erection. Some growers dig in a layer of about 8–10 in. of manure to provide a little bottom warmth, and to assist in the moisture-holding capacity of the soil. This manure is covered with about 6 in. of good soil, enriched, if necessary, with old leaf-soil or moss-peat. If the work of early preparation commences in early autumn the rains falling on the cultivated soil are absorbed and held in reserve by the subsoil for the use of subsequent crops. Further, the cultivation and manuring makes the soil warm and easily worked. At least four crops will be grown on this land, hence it is very well worth while to do the work of preparation thoroughly. Each season more manure is added, thus the humus content of the soil is increased annually. It is usual to change the site of the frameyard after three seasons of cropping, but this depends upon specific conditions. Local conditions may also regulate the depth of ploughing or digging; it has been observed in more than a few instances that crops thrive just as well with a combination of shallow tillage and heavy organic manuring, although, as a rule, deep cultivation is essential for producing the best crops.

Erection of the Frames. Some at least of the frames should be erected and ready for planting by the first week in January.

Strips 5 ft. wide are marked out for the ranges of single-span frames with 18-in. pathways dividing them. The frames are erected on raised beds as described in Chapter Five. The soil in the frames is raked thoroughly with the wooden rake and finished off with the iron rake so that the level is 7 in. from the top of the back board, and about 4 in. from the top of the front board, in the single-span type.

All stones and large lumps are removed. If available, a dressing of "terreau", or of moist peat-moss, may be applied before the final raking. In some soils it may be necessary to add a fertilizer, such as bone meal, 2 oz. per sq. yd., or a balanced mixture such as 1 part sulphate of ammonia, 3 parts superphosphate, 2 parts sulphate of potash.

The back of the iron rake can be used to level off finally.

The lights should be placed on the frames ten to fourteen days before planting in order to warm up the soil and protect it from excessive wet and frost. The lights may have to be covered with straw or mats if severe frost is expected. The sides of the frames are well banked with soil so that draughts are excluded, and this is further helped by placing heavy dressings of straw or litter in the pathways. The straw or litter serves also to conserve moisture and facilitates walking between the frames in wet weather. At the end of the season this straw or litter is dug or ploughed into the soil further to increase the humus content. Even a light dressing of straw helps to prevent the soil in the pathways from "puddling", and allows winter rains to penetrate the soil.

Sowing Carrots. The next operation is the sowing of the carrot seed. Special varieties should be selected which are early, colour well when young, are without any pronounced tendency to "green" at the shoulder, and which possess a relatively small top (leaf) growth. Such varieties are Amsterdam Forcing (Primo), Broadcast, Xmas Candle, and others.

Sowing should be done on a fairly calm day if possible, and an endeavour should be made to sow uniformly and fairly thickly. The aim is to drop the seeds at ¼ to ¾ in. apart (approximately ⅛ oz. per Dutch light); this requires practice, but the work may be facilitated by mixing the seed with dry sand before sowing. The seed is then scratched in with a sharp-tined fork. The favourite tool for this purpose is an old and rather worn dung fork. An iron rake may be used instead, but it is not such a good tool for the purpose as the dung fork used skilfully.

Next a sprinkling of hydrated lime is applied, and the soil gently firmed with wooden pressers usually about 2 by 1 ft. The beds are then marked out in 9 or 10 in. squares ready to receive the lettuces previously pricked out in other frames. Squares may be scratched out in the frames by means of a marker similar to that described for the pricking-out frames, the nails being placed 9 or 10 in. apart. This marker gives a series of parallel lines along the length of the frame. The squares are completed by means of another marker made like a larger wooden rake with nails at 10 in. apart forming the teeth. This is drawn from the back of the frame to the front (Fig. 3).

The lettuce seedlings are then carefully "lifted" with some soil from the frames in which they were pricked out. The root systems should remain intact and the plants separated with great care. The seedlings are dibbled into their final positions with a dibber that should be blunt at the end—not pointed. Each seedling should be planted so that it sits on the soil, neither too high nor too deeply, with the seed-leaves resting on the soil. The roots should be well firmed in, after placing them in the hole with the tap-root straight downwards and not curled around. They are planted alternately or "staggered", that is the first row is planted at the point of intersection of the lines forming the squares, and the second row is planted along the next line but between those in the first row. In the third line the plants are opposite those in the first line and so on. Thus the maximum amount of space is given to each lettuce plant. The work need not be held up in moderately hard weather, but if rain occurs, then the work must cease and the lights be replaced at once, unless a shelter is erected over the planters at the frames.

As soon as the planting is completed the lights are put on and kept closed right down. If the weather is exceptionally sunny, it will be necessary to shade the lights until the plants are established. No ventilation whatever is given to the frames while the lettuces are in them, except after frost at night, when the frames should be ventilated, preferably at the bottom, to allow the thaw to be gradual. Thus the work is done before the sun strikes on the light, and as soon as the frost is out of the frame the lights are shut down again. In practice this usually means airing before breakfast on frosty mornings and closing down again soon afterwards. The frames may also be open on exceptionally hot sunny days in April when the lettuce plants are getting large and the leaves are rather close to the glass, especially the variety May Queen. It is then often advisable to ventilate for half to one hour during the hottest part of the day to prevent flagging and scorching of the leaves. This operation must be done with discretion and every effort must be made to keep up the moisture content of the soil. It is maintained that this is assisted by ventilating at the bottom end of the frames rather than at the top, as the hot air rises to the top and the moisture condenses inside the glass of the frame. The direction of the wind must also be considered. On rare occasions ventilation may be necessary earlier in the season if the weather is exceptionally hot. Ventilation is best done by means of wooden blocks. These blocks should be placed so as to support the wooden sides of two lights and not in the middle of each individual light. This results in the lights being more rigid and level, and less likely to be blown off by a gust of wind.

For the next few weeks the chief work in the frames is the removal of weeds as soon as possible and thinning the carrot seedlings. It is also important to keep a sharp look-out for diseases and pests. Slugs may be troublesome, and may be controlled by baits (see Chapter Twelve). Other insects such as "cut-worms" and wireworm may cause serious losses among lettuces. Botrytis is a serious fungus disease of lettuces, attacking the leaf-stalk and the main stem at the "collar" and resulting in rotting and death of the plant. Mildew can sometimes prove serious although a certain amount is often experienced without great damage to the crops (see Notes on Plant Diseases, Chapter Twelve). From the cultural aspect of control of these troubles care should be taken to remove all infected leaves and plants. If losses occur soon after planting in the frames, it may be worth while replacing the failures with healthy plants, having first removed and burnt all trace of each affected plant together with some of the surrounding soil.

However well sown, it will probably be found necessary to thin out the carrot seedlings; this is usually done when weeding and should not be too severe.

Turnips or radishes may be sown between the lettuces when these are about half mature, but since they do not thrive well in congested conditions they are best left out of the cropping series and grown as full crops separately in other frames.

Planting Cauliflowers. When the lettuce are nearly ready to cut (Fig. 20), cauliflower plants, raised as described on p. 107, are transplanted, five to each frame (Fig. 21(*a*)). Under the first light in a row there are three plants near the back and two near the front of the frame. In the second light there are two at the back and three at the front, and so on. Thus each plant receives the maximum amount of space. Another spacing arrangement is shown in Fig. 21(*b*). By planting before the lettuce are cleared the young cauliflower plants have an

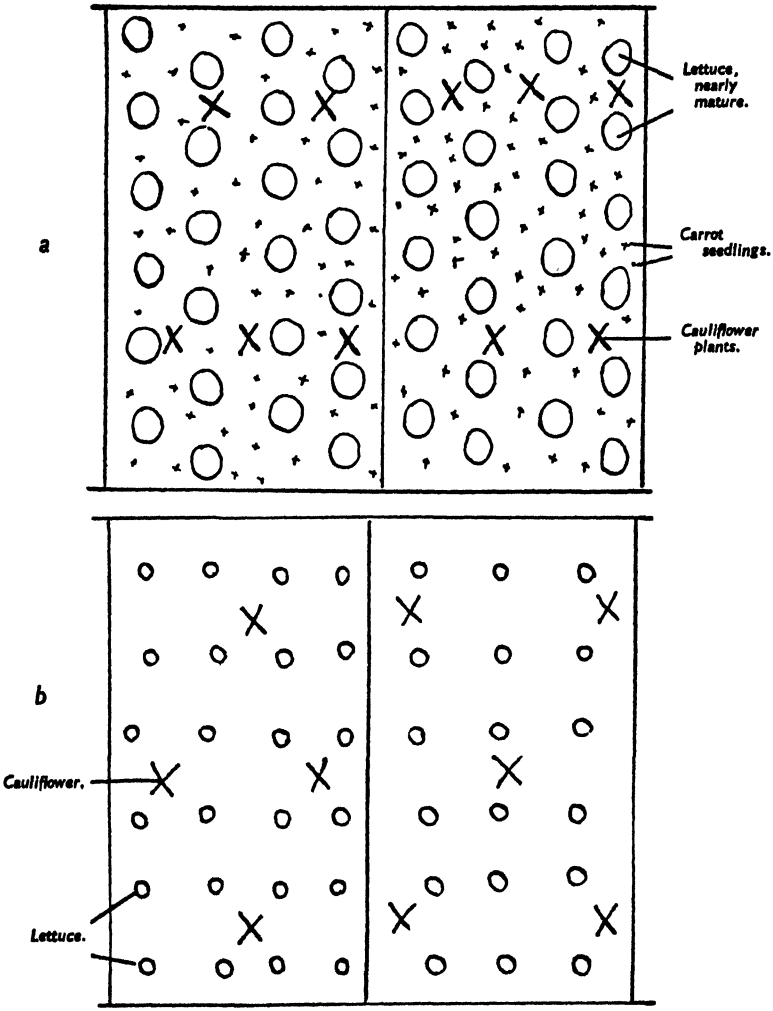

Fig. 21.—DUTCH LIGHT GARDENING.

(*a*) Diagrams of intercropping under two adjacent Dutch lights showing lettuce (nearly mature), cauliflowers (just planted) and carrot seedlings.

(*b*) Another planting plan for lettuces and cauliflowers under two adjacent lights.

opportunity to become established before the lights are removed or the frames ventilated.

They are best planted with a trowel, and care should be taken to keep the roots intact and as much soil attached to them as possible, and they will probably need to be watered in. Any check from transplanting or injuring may cause the plants to "go blind" (failure of the terminal shoot) or to "button-in" (produce tiny premature heads or curds).

Cutting and Marketing of Lettuce. The "first-fruits" of the frames are the lettuce. These should only be cut when fully hearted, usually during April, and cutting should be done early in the morning. The method of procedure is as follows: One light is removed from the end of the range and placed on its neighbour. Two men work to each range, one at the back and the other at the front. Any lettuce which appears to be mature is tested by a gentle downward pressure of the back of the hand (squeezing the heart between the thumb and fingers tends to damage the lettuce). If the lettuce is sufficiently firm it is then cut with a sharp knife close to the soil level (a well-worn sharp table-knife makes an excellent tool for the work). As the lettuces are cut they are carefully placed on the adjoining light. The roots are left in the ground, but any loose leaves or decaying material are removed, and afterwards, if possible, collected and burnt so as to eliminate the possibility of disease infection from this source.

As all mature lettuce from one light are cut the next light is slid along so that the lettuce under it are accessible. When the work is done by one man alone a prop is used to hold up the light. Packers follow the cutters and place the lettuce carefully into containers ready to be taken to the packing shed. Here they are handled one at a time; the cut stalks are trimmed neatly and cleanly and any defective leaves are removed. The lettuce is then placed face downwards on a canvas table and when the table is full the whole are well washed with a gentle spray from a hose-pipe with a rose, or a watering-can with rose attached. The surplus water is allowed to drain away and then the lettuces are placed carefully into standard-sized non-returnable wooden crates.

These crates are lined with paper, preferably "pale blue sealing". The first layer is placed face upwards, then a sheet of paper is placed on top of the lettuce, and then another layer of lettuce is packed on top face downwards, the lining paper is folded over and the box closed with two or three wooden slats nailed across to form a lid. Some growers pack both layers of lettuce face downwards.

Grading and packing are usually effected at the same time. It is important to grade accurately and fairly. Lettuce may be packed in boxes containing 18, 24, 36, 42, or 48. The usual sizes are 24 and 36. The National Mark grading requires lettuce to be not less than 3½ in. in diameter when reasonably compressed by the hand, and each lettuce must be sound, fresh, crisp, of good colour, and hearted. Each crate is labelled clearly, showing the count (grade), sender and destination.

Watering and Weeding. As soon as the lettuce are cut ventilation is given to the frames and in a day or two the carrot seedlings will have become a darker green shade. Water must then be given freely, and the best method on a large scale is by means of the overhead sprinklers (overhead irrigation), dealt with in Chapter Four. The watering can be done with a watering-can and rose, if on a small scale, or even with a hose-pipe with rose. Whatever system is employed the work must be well done, for the land will need a thorough soaking, and frequently the overhead pipes should be set to spray on a block of frames for three to four hours.

The lights are then replaced but adequately ventilated by wooden blocks. From now on watering must be consistent, and the grower will be rewarded by the remarkable recovery of the carrot seedlings, previously crowded by lettuces (Fig. 22). At the same time, while the lights are displaced, if weeds have not all been cleared, they will pull up very easily after the watering, and as the water will help them as well as the carrots and the cauliflowers, it is very important that they be removed without delay. Ventilation is increased gradually so that the plants in the frames are hardened off.

Meanwhile the cauliflowers may have grown too tall for the frames before the lights are removed altogether. It is possible to increase the depth of the frame by raising the boards. Two men lift each board with wire hooks while another man places a block of wood or a brick underneath to hold it in position. The gap beneath the boards and soil is then filled from the pathways. This is more easily done with the box type of frame than with the frames built of loose boards.

Marketing Carrots. The carrots are pulled in May, but several weeks may elapse before they are all cleared, as they do not all mature at the same rate. The beds are watered so as to facilitate pulling the carrots by hand, and to encourage growth of the other crops in the frame. The work is usually done by women, who bunch the carrots into average handfuls as they pull them, tying them together with raffia or fillis twine. The approximate number in a bunch varies from six to thirty, according to the market. The first carrots pulled are about 2 in. long and of good colour. The bunches are dipped in a tank of water, allowed to drain, and packed in paper-lined non-returnable wooden boxes usually holding one dozen bunches each (Fig. 11).

Marrows. Meanwhile the marrows, sown under glass in early May and brought on in 60-size pots, are planted out in the frames, spaces being cleared among the remaining carrots if necessary (Fig. 23).

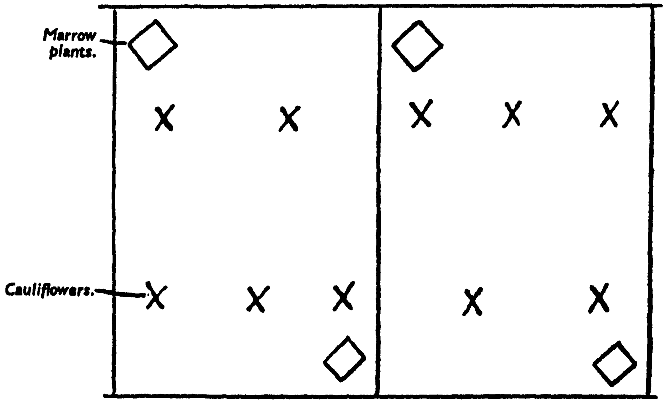

Fig. 23.—DUTCH LIGHT GARDENING. Diagram showing positions of cauliflowers and vegetable marrows in the frames.

Bush Green varieties are the most suitable and usually sell better than the white or cream sorts. Varieties and strains having a short-jointed habit should be selected.

Two plants are placed in each light, a plant at the top left-hand corner and the other at the bottom right-hand corner.

They should be watered in, and if necessary protected from frost and cold winds, although the leaves of the cauliflowers provide a good protection for them. These marrow plants must not be allowed to get dry, and may need a little artificial manure as a top dressing, watered in when the plants are well established.

It is advisable to pollinate the female flower of each marrow plant with the pollen from a male flower in order to assist fertilization or "setting" of the fruit. The female flowers have an embryo fruit present in the form of a small swelling below the petals, and if fertilization does not occur these may turn yellow and drop off. The operation is best carried out each morning, as the flowers are short-lived. The frames have now been cleared of lettuce and some carrots and contain at this time, about late May, cauliflowers, marrows and the remainder of the carrot crop. Heavy waterings are necessary during the next few months (Fig. 24).

Marketing Cauliflowers and Marrows. The next crop to be marketed consists of the cauliflowers, which should be ready about early June. As each head nears maturity it is advisable to break a leaf over the curd to afford protection from the weather. When mature, the cauliflowers are cut with a large sharp knife, or special tool, the leaves cut off neatly and cleanly a few inches above the curd, and the stalk and loose leaves cut off. They are then packed firmly into non-returnable crates, stalks outwards, and each crate holds 12, 18, 24 or 36, according to the size and grade. Grading for size and quality should be done strictly. After the cauliflowers and the remainder of the carrots have been cleared, the marrows are the only crop occupying the frame, and in a short time fill up the space and grow over the boards into the pathways. The plants will probably need frequent thorough waterings. Marrows are fit to cut from the frames about the end of June. They are cut when quite young and only about 6 to 10 in. long, when they are usually in good demand for hotels, etc. They are packed in hay-lined crates, each holding 6 or 12 marrows.

Autumn Treatment. When the outdoor-grown marrows become plentiful, the price realized for frame marrows may drop considerably, and it will probably be worth while to

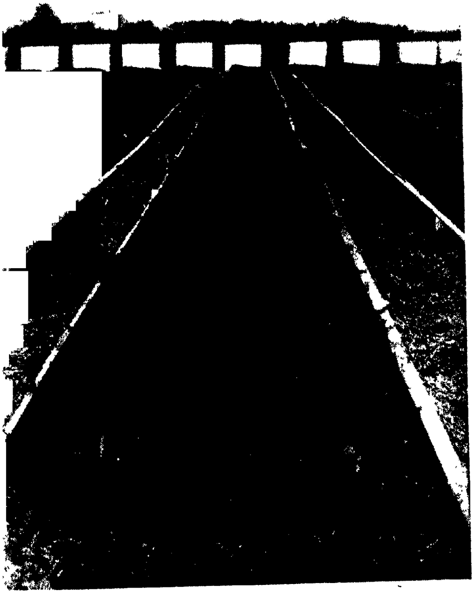

Fig. 22.—DUTCH LIGHT GARDENING. Carrots and young cauliflower plants photographed in May. Lettuces have been cleared from these frames and the remaining crops well watered (see irrigation pipe on right).

Fig. 24.—DUTCH LIGHT GARDENING. Cauliflower (intercropped with young marrov plants) being irrigated. Lettuce and carrots have previously beer gathered from the frame. *Photo Farmer and Stockbreeder.*

clear away the plants to the compost heap. The soil can then be dug over and a balanced artificial manure added, afterwards well raking and preparing for an autumn crop of lettuces or endive. Suitable varieties are: *Lettuce*, All the Year Round; *Endive*, Moss Curled.

Unless the soil is of a very fertile nature it is as well not to attempt this autumn crop of lettuce following the other crops. Apart from the fact that producing this extra crop means additional labour costs, there is less opportunity for thoroughly preparing the soil for the following season's series of crops. Intensive systems demand a great deal from the soil, and a short rest from cropping may often effect real economy. Such late crops sometimes delay the preparation of the frames for the following season's crops, with consequent late sowing and planting and harvesting, resulting in reduced cash returns.

The Dutch lights which have been in use during the summer for protecting other crops or for making a glasshouse, or have merely been stored, should now be stacked in a dry shed after being thoroughly cleaned. At least every three years the lights should be repainted, unless they are made of cedar wood. The autumn preparation of the frame soil follows the usual lines, but it may be mentioned that small power cultivating machines such as rotary tillers are very useful for working the soil in the frames. The rotary type of cultivator cannot be wholly recommended for use on very sandy soils as it tends to make too fine a tilth, with the result that these soils then settle too solidly.

It is not yet known how long these cropping systems may successfully be carried out on the same piece of land, but with adequate manuring three years' successional cropping should be quite satisfactory since the system is itself one of rotational cropping.

Other Systems of Dutch Light Cropping.

Dutch "settlers" in the East Riding of Yorkshire have introduced a method of utilizing Dutch lights to give temporary protection to newly-planted crops until they are established. The double-span type of frame is almost universally used. The lights are transferred from one crop to another and are in constant use (Fig. 4).

The land is divided into a series of beds of a width that can be covered with a double-span frame, with narrow pathways between.

Lettuces. Lettuce seedlings (var. May Queen [Dutch seed]) are raised by sowing in frames in October, and later thinning or transplanting to other frames. The first beds to be covered with lights are planted with lettuces in December, and after a period of 2–3 weeks, the lights are moved on to another batch of lettuces. The last lettuces to receive protection in this way are planted out in March.

Cauliflowers. These are sometimes grown by themselves, but are more frequently interplanted with the lettuces. The plants are raised in autumn and wintered in frames as described earlier in this chapter. The lights are moved on to successive plantings and the crop is marketed from June to the end of July. The favourite varieties with these growers are—Veursche of Veentjes, Soorte Remme and Lecerfs Zelf-dekker, though such varieties as Early London, Pioneer and White King are also suitable.

Radishes. Two or three successive sowings are made in frame beds from January to March. The first crop is protected by lights until it is marketed about the end of February. Later sowings are uncovered shortly before pulling, thus the radishes "bottom-up" more satisfactorily. They are marketed in March and April.

Carrots. The frames in which these are grown are usually kept covered with lights for a long period, as carrots do not respond to the system of temporary protection.

In Yorkshire, sowings are made as early as September and October to provide young carrots in late Spring.

Spinach. The round or summer type is sown in February or early March and covered with lights for about 4 weeks (until the first true leaves are formed). It is a popular crop with these growers and is fit to market in April.

Strawberries. This crop is useful in the rotation of lights as those used for covering cauliflower seedlings are usually available for protecting the strawberries in February. Fruit is usually picked in mid-May. The plants, which are planted 6 by 6 in. apart, remain in the beds and are allowed to fruit in the open next year, after which they are destroyed. Varieties are Madame Lefebvre, and Deutsch Evern.

Onions. Seed of the variety called Zwijndrechtsche Pootuien (an Ailsa Craig type) is sown in August. The seedlings are transplanted to their final positions in March or April and are harvested in July. They are often interplanted with "maiden" strawberries.

Tomatoes. During summer, some growers transfer the lights to cover tomatoes, forming temporary glasshouses called "Warenhuizen" (Fig. 4). These are simple but apparently effective structures of which the lights form the sides, ends and roofs. There are various methods of securing the lights but usually a 1½-in. nail is driven into the ridge and the gutter and a similar nail into either end of the lights and these are wired together. Ventilation is provided by a special "ventilating light." This is divided in half with one end on a pivot, and is held in position merely by a cord. Most of these houses are unheated. Glasshouse builders offer Dutch light houses which are more solid in structure. One type can be erected and dismantled in sections, each consisting of four lights hinged together. The tomatoes are usually planted in four rows per house—planting a double row under the ridge and a single row near each gutter. It should be mentioned that the methods adopted by these growers are very varied, and much is still in the experimental stage. Temporary protection is apparently of little value under English climatic conditions and many growers practise a cropping system that is fundamentally similar to that already described in this chapter.

Chapter Nine

Cloches and Other Small Protecting and Forwarding Devices

Cloches and similar devices are designed to protect plants and germinating seeds from the effects of cold winds, heavy rains and to some extent from frost. They form very useful accessories for the intensive market-gardener. The type known as the "continuous cloche" is particularly popular.

The French Cloche, Bell-Jar or Bell-Glass (Fig. 12). Cloches form an important part of the French Garden equipment and management, and their description and use has been fully discussed in Chapter Seven on French gardening. The glass is very thick and provides an appreciable amount of protection from frost; but the cloches are rather heavy to handle. The plants are given the maximum amount of light, and receive no drip as condensation moisture runs down the side of the bell-glass. Ventilation, if necessary, has to be effected by means of notched pegs, or by depressing the soil at two opposite points at the base of the cloche. The value of French cloches to the average grower is limited, since they are best used in conjunction with some form of hot-bed.

Continuous Cloches (Figs. 25, 26 and 27). These consist of two or more panes of glass held together by a wire framework or other means of support. The two most popular types in use at present are the tent (consisting of two panes of glass) and the barn (four panes of glass). The cloches are placed touching one another in rows so as to form a continuous range. The ends of the ranges may be closed by a sheet of glass or wood held in position by a wooden or iron stake. Permanent ventilation is

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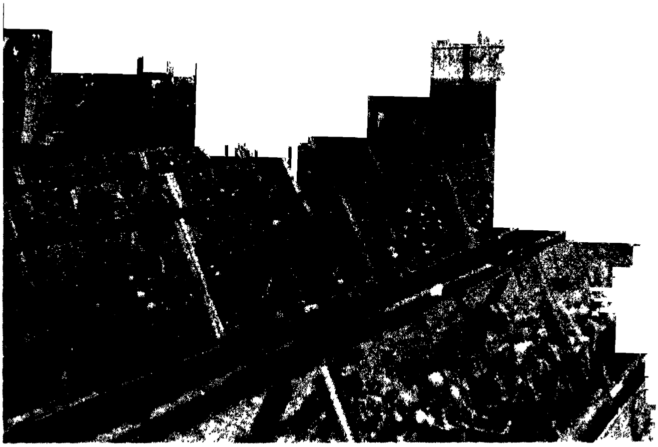

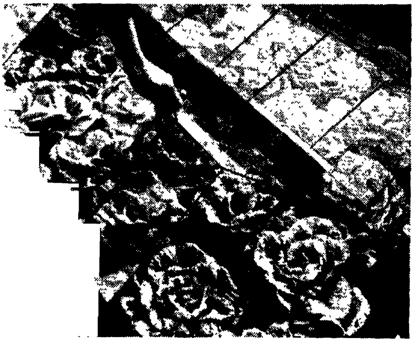

Fig. 25.—CONTINUOUS CLOCHES used for protecting lettuces.

27.—TOMA-
S fruiting under
ome-made"
hes (the "barn"
tern).

provided in nearly all types by means of small spaces between the sheets of glass. They are simply constructed, portable, easily repaired, and can readily be dismantled and packed away in a small space when not in use. Their chief virtue is probably that plants are protected against excessive rain and wind while still able to receive the maximum amount of light. This covering not only encourages more succulent growth of the parts above the ground and protects them from damage, but root growth is encouraged by reason of the warmer soil. The cloches may be placed in position some time before sowing or planting takes place, so that the soil is kept in the right condition for the work, if very wet weather or frost follows. It should be remembered that they are not proof against severe frosts, and semi-hardy or hardy varieties of plants are therefore most suitable. Protection against frost can be obtained by covering the cloches with straw, mats or litter. Their popularity has increased rapidly in recent years, particularly in the south of England, and in other parts where the weather is mild.

In order to use these protectors to the fullest advantage a certain amount of planning and "timing" of crops is necessary, so that the cloches may protect successional sowings, transplanted seedlings, or established plants as required. Thus, in Hampshire, their value to strawberry growers was established at the Botley Experimental Fruit Station and at the Farm Institute, Sparsholt. These growers now produce early strawberries under cloches that have previously been used in the autumn and winter for protecting violets and lettuces. The larger types of cloches may be used for tomatoes, trained horizontally, during the summer months (Figs. 26 and 27). When used for lettuce and other salad crops the cloches are best set out in double rows on slightly raised beds. Suttons' Imperial and Improved Trocadero are excellent varieties for autumn production under these cloches; and for winter and early spring, Stanstead Park, Suttons' Arctic, Arctic King, Harrisons' Excelsior, and Winter Victor are suitable.

Well-hearted spring lettuce can be produced under these cloches, to follow those from the cold Dutch frames, by using the varieties May Queen and Feltham King.

Early radishes are a suitable crop under cloches, since ample ventilation can be given.

By skilful management the cloches may be used to protect, successively, such crops as autumn lettuce, corn salad, endive, early parsley, radishes, mint, spring lettuces, vegetable marrows, French beans, peas, strawberries, raspberries (pegged down) and tomatoes. The tomatoes can be afforded protection throughout the season by laying clean straw along the rows and stopping and pegging down the plants when three trusses are set.

Intensive cropping systems may also be devised, such as broadcasting or drilling radishes or carrots, and then planting lettuces intercropped with cauliflower plants. The barn type of cloche is necessary for this system. Marrows may take the place of cauliflowers. It should always be remembered that the continuous cloche is a "protecting" and not a "forcing" device.

Evesham Hand Lights, "Cap-Glasses" or "Conicles". These protectors are substitutes for the French cloches. They are both larger and lighter than the cloches, but do not allow as much light to pass through on to the plant, and are not airtight.

The cap-glasses consist of eight glazed sides tapering to form a cone and held together in a zinc frame. Each side comprises three small panes of glass. They are 15 in. high and about 20 in. wide at the base. A small hole is left at the top of the cone that provides ventilation, and that, by insertion of a finger, can be used as a means of lifting the cap. These lights may be used for similar purposes as the continuous cloches. Cap-glasses are still used extensively in the Evesham district for protecting early plantings of cauliflowers and marrows, but for lettuce production they are gradually being displaced by Dutch light frames.

Other Protectors. Various other devices for protecting crops are in use, but while some may be valuable to the amateur they do not have a wide appeal to the commercial grower. They include collapsible sunboxes, "semi-permanent" continuous cloches, round zinc rims and others.

Experiments are being conducted at the Hertfordshire Institute of Agriculture on the effects of soil-warming by means of hot-water pipes for forwarding open-air or cloche-protected crops, but the work has not yet been in progress sufficiently long to justify the publication of any results.

Chapter Ten

Glasshouses

Apart from tomatoes and cucumbers, which are not dealt with in this book, lettuces form the most important salad crop grown in glasshouses in this country. Mustard and cress, radish, chicory and dandelion may be grown also in glasshouses, though the last two crops mentioned require dark conditions for forcing.

Lettuce. It is only during the last twenty-five years that the production of hearted lettuce in glasshouses has become a commercial enterprise. Previously lettuces were grown that consisted of a few tender leaves with little or no heart, and these were known in the trade as "butterflies". They commanded a good sale until the advent of the large-hearted Dutch and Spanish lettuces. As a result, seedsmen, research stations and growers turned their attention to the selection and breeding of suitable varieties to compete with the foreign importations. Extra impetus was given to their efforts by the introduction of tariffs on foreign produce in 1931.

Varieties. The object of glasshouse lettuce producers is to provide hearted lettuce to supply the market from December to March. This is by no means easy, since the majority of lettuce varieties require ample daylight in order to "heart-in"; and it is even more difficult in districts where fogs are experienced. The introduction of the variety Cheshunt Early Giant has made it possible, in some districts, for first-class hearted lettuces to be produced even at Christmas. Many other varieties are suitable for cutting in March. The choice of varieties is extremely important and growers are strongly advised to make comparative trials of different varieties and different strains of the same variety in their own glasshouses. The success of one sort in a certain district is no guarantee, even when grown under strictly comparable cultural methods, that it will be satisfactory in another district. For instance, the variety Cheshunt Early Giant has proved a wonderful variety for cropping in winter at Cheshunt and many other districts, but elsewhere some growers entirely fail to grow it successfully, although in the same nurseries other varieties such as Early French Frame succeed. The following varieties have been successfully grown in heated glasshouses:

Cheshunt Early Giant
Gotte à Forcer
Coucher à Graine Noire
Loos Tennis Ball
Early French Frame
Blackpool
Golden Ball
Forcing Milly
Harbinger
Delicatesse
Little Black Gotte (Laitue Petite Noire à Chassis)

Houses. Lettuce may be grown in heated or unheated houses. The most suitable type of house is one that allows the maximum amount of light to reach the plants and that is airy and amply provided with ventilators.

Thus the "aeroplane" type is much favoured and also that made with Dutch lights, whether permanent or temporary structures. Lettuces are grown, with varying degrees of success, in many different types of houses.

Soils. Light loams are preferable for lettuce, and although there are some successful growers of lettuce in houses on heavy land, the average grower is advised not to attempt to grow this crop if his soil is a heavy, cold clay. For lettuce cultivation under glass it is essential that a good fine tilth be produced, and this can easily be effected on light sandy soils. Moreover, such soils warm up easily, and encourage quick root action and rapid growth. It is very desirable that the soil should have a good natural water supply or be capable of holding ample moisture as a sponge. The addition of organic manures or of sphagnum peat-moss is therefore beneficial in increasing the water-holding capacity and general fertility of the soil. If peat-moss is applied dressings of from 10 to 15 tons per acre have been recommended, or alternatively applications of 5 to 6 tons per acre over a period of years, as a mulch to the tomato crop.

Preparation of the Soil. Usually lettuce forms a catch crop between two crops of tomatoes, in which event the soil is double dug and basal manures for the tomato crop are applied before the lettuce are planted. Further manuring for the lettuce is usually unnecessary, though in some instances a light dressing of hoof and horn might be beneficial. Thorough preparation of the soil is essential, and the wooden and iron rake should be freely used, breaking down lumps and removing all stones and coarse organic debris. This lessens the risk of Botrytis disease.

Sterilization of the soil with 2 per cent formalin seven to fourteen days before planting minimizes the risk of disease. One gallon of formalin (40 per cent formaldehyde) is added to 49 gallons of water and applied with a watering-can and rose to 60 sq. yd. of the surface. Some growers apply the same quantity of solution (50 gallons) to only 10 sq. yd. The surface of the soil should be thoroughly stirred with sterilized rakes several times in order to disperse the formalin fumes which would otherwise scorch the plants. In nearly every instance it will be found advisable to flood the beds and pathways carefully a few weeks before planting, so that ample water is held in reserve in the subsoil and topsoil without the land being actually sodden.

If the soil is to be chemically sterilized the flooding should be done first.

Heated Houses. Lettuces may be produced as the sole crop occupying the houses or as an intercrop with tomatoes, carrots or radishes.

(*a*) Houses Devoted to Lettuce Crops Entirely (Fig. 28).

Raising the Plants. Seed may be sown in specially prepared borders in heated glasshouses or frames, but most growers prefer to raise plants by sowing thinly under glass in boxes of sterilized soil, transplanting 1 in. apart into other boxes, ten to fourteen days later, when the seed leaves have developed. About 1 oz. of seed is sufficient to raise 15,000 to 20,000 plants, and an ordinary tomato seed-box takes about 300 seeds. Alternatively, certain varieties, such as Loos Tennis Ball, are sometimes sown thinly in 12-in. drills directly into the glasshouses and later thinned out to a distance of 6 to 10 in. apart. Under good conditions pricked-out plants should be ready for their final positions in the houses in about fourteen days after pricking out. For cutting in the following February or March sowings should be made in the first and second week of October, but if for December cuttings it is necessary to sow in early September.

Planting Out. Before planting out, it is wise to dip each box carefully in a tank of "tepid" water so as to damp the soil thoroughly without unduly wetting the leaves and stems of the seedlings. The boxes should be stood in the planting houses a day or two and then the plants may be carefully placed in their final positions. Great care must be exercised not to damage the seedling leaves or roots, and they must be planted so that they "sit" on the soil neither too deeply nor too shallow. The experiments conducted by Mr. Macpherson in Lancashire, and by Dr. R. H. Stoughton at Reading University, showed that, under the conditions of the experiments, crops of lettuces matured about a week earlier when planted on ridges of soil.

The spacing of the plants depends upon the variety grown. The large types, such as Loos Tennis Ball and Blackpool, should be spaced 10 by 12 in.; the medium-sized types, such as Cheshunt Early Giant and Early French Frame, at 9 by 10 in.; and the small varieties, such as Gotte à Forcer, Golden Ball and Coucher à Graine Noire, at 7 by 9 in.

The houses may be cold at the time of planting and heated in spring, but it is better to have a little heat on for the commencement. An average temperature of 50° (varying between 45° and 55°) should be maintained.

Ample ventilation must be given whenever conditions permit. Thus on cold, damp days, and especially during foggy weather, the ventilation should be much restricted, but immediately weather conditions improve the ventilators should be freely opened. Sometimes it is possible to open the doors also, but in certain districts this encourages sparrows, which often cause considerable damage to the tender lettuce plants during winter.

Table of Operations for Lettuces in Heated Glasshouses

Variety	*Seed sown*	*Planted out*	*Marketed*
Cheshunt Giant	Sept. 10–15	Sept. 25–Oct. 7	Christmas
,, ,, ...	Oct. 8–15	Dec. 1–10	Feb. 15–20
,, ,, ...	Oct. 20–30	Dec. 15–20 (tomatoes to be interplanted later)	Mar. 10–21
,, ,, ...	Jan. 4–8	Jan. 30	Mar. 18–21
Loos Tennis Ball . . .	Oct. 15	—	Mar. 15
Blackpool	Oct. 15	—	Mar. 15
May Queen:			
1st crop	Sept. 8–15	—	Mar. 1–7
2nd crop	Nov. 15	—	Mar. 15–18

Watering. It should not be necessary to water-in the plants, but after the first fortnight watering should be done at regular weekly intervals, providing that the weather is favourable, and depending upon the soil texture, etc. It is not wise to water during continued foggy weather. Watering of any plant is a fine art and should be carried out most carefully by an experienced man, and not by the youngest apprentice. The watering of lettuces under glass is best done with a hose-pipe to which is fixed a length of 2 or 3 ft. of iron piping or alternatively a bamboo cane tied to the extremity. The water is applied around the plant holding the nozzle close to the soil, forming a ring, so that no water falls on the leaves.

While this is the orthodox and the safest method of watering the crop it should be mentioned that the writer has seen excellent crops of lettuces (var. Cheshunt Early Giant, Harbinger and Blackpool) produced by growers who have consistently watered them by overhead spray applied with a watering-can or hose-pipe with spray nozzle attached. Undoubtedly the skill of the growers concerned and the prevailing weather had much to do with the success of the method. The watering was done with discretion, that is only during favourable weather and during the early part of the day. Whatever method is used it is unwise to water late in the day, as the soil may remain cold and wet for several hours afterwards, with the result that the plants suffer a check and mildew infection may follow. When possible, it is worth while raising the temperature of the house after watering to minimize this tendency.

The soil between the plants must be frequently hoed as this conserves moisture and aerates the soil, and makes a remarkable difference to the growth of the plants. Care must be taken not to damage the lettuce leaves with the hoe.

Control of Pests and Diseases. Careful watch must be maintained, particularly against serious infection by Botrytis disease. Dr. Bewley of Cheshunt Research Station recommends regular inspection of the plants each morning, all infected leaves being removed and burned at the first sign of disease. A boy can be trained to do this work. It is not wise to water overhead, excepting when the crop is nearly mature and when the weather is warm in March. Botrytis and heart-rot disease appears to be encouraged by such procedure. Greenfly sometimes becomes a serious pest, and can make a crop practically unsaleable, or spoil the grower's reputation on the market. If taken in time nicotine shred fumigation carefully carried out is a practical control in glasshouses.

Further notes will be found in the chapter on Pests and Diseases.

Cutting and Marketing. The crop should preferably be marketed when fully hearted. In the northern markets, however, unhearted lettuces can still be sold, and in any case the grower may find that the crop must be cut before fully mature in order to avoid delay in planting the succeeding, and probably more important, crop. Choice of correct varieties and times of sowing will help to avoid such a situation. The lettuce should be cut in the early morning, the stalks being trimmed and all discoloured leaves removed. They should be washed and packed as described in Chapter Eight on Dutch Light Gardening.

(*b*) LETTUCE AS AN INTERCROP WITH TOMATOES. This system is adopted when it is expected that the tomatoes will have to be planted before the lettuce are quite mature. The rows for the tomato plants are marked before planting the lettuces.

Tomato plants are usually set out in rows alternately 27 in. and 18 in. apart. In the 27-in. space, three rows of lettuce are planted approximately 9 in. apart each way. In the 18-in. space only one row of lettuce is planted. If the tomatoes are spaced out differently, the lettuce rows are adjusted accordingly. The lettuce must be cleared before the tomato plants become large and throw too much shade. On most nurseries this means that the lettuce plants must be in their final positions not later than the second week in December. The tomato plants are put in between the lettuce usually in February or March. The box method of raising plants and general details of cultivation and marketing follow similar lines to those described under (*a*) on page 129. If the lettuce plants become infested with greenfly they will probably infect the tomato crop also, unless the houses are fumigated to kill the pest. It is not always considered worth while to heat the houses especially for the lettuce, but some heat is applied about fourteen days before planting the tomatoes in February or March, in order to warm up the soil. Great care must be exercised by the workers in carrying out operations among the plants. It is quite easy to damage the lettuce crop by carelessness when planting the tomatoes, and later the tomato plants may be knocked about by men when they are cutting the lettuce for market. This factor of inconvenience is one of the main objections to this system. The crop is usually cut in March.

(*c*) LETTUCES INTERCROPPED WITH CARROTS OR RADISHES AND TOMATOES. This system is suitable for growers who do not plant tomatoes until March or April. Some growers proceed as follows: The wires for supporting the tomatoes are about 2 ft. apart, and underneath them a row of lettuce is planted. In between these, drills 6 in. wide are drawn with a draw-hoe, as for peas in small gardens, but very shallow. Carrot seed, variety "Primo", is broadcast thinly in these drills and just covered with fine soil. The lettuces (var. Cheshunt Giant, Blackpool, or Black Gotte (Laitue Petite Noire à Chassis)) are raised by sowing under glass at the end of October or the first week in November. They are pricked out once in the usual way and are planted out 10 in. apart in between the carrot drills and beneath the tomato wires.

The lettuces are cut in March or early April and in their places the tomatoes are immediately planted.

The carrots are marketed at the end of April to May, leaving the house entirely to the tomato crop.

Radishes may be grown similarly in between the tomatoes, sowing being done very thinly in wide drills, using varieties such as Short Top Forcing, Glowing Ball and French Breakfast. It is unwise to attempt to grow radishes or carrots in this way if the soil is at all heavy, as growth will probably be slow and cropping unsatisfactory.

Lettuce in Unheated Houses. Lettuce crops grown in unheated houses are naturally slower in growth than those produced in heated houses, and where heat is available it is easier to maintain a buoyant atmosphere during periods of dull, damp weather, therefore lessening the possibility of disease. Occasionally severe frosts have been known to damage lettuce in unheated houses. Nevertheless in some districts unheated houses are used extensively for lettuce production, particularly during spring for cutting from March to May. Such crops usually take the place of chrysanthemums in the rotation.

In Cambridgeshire the plants are usually raised out of doors or in frames. Thin sowings are made out of doors in well-prepared seed-beds from the third week in July to the third week in August. Those raised in cold frames are sown during September. The seedlings are not pricked out but are taken from the seed-bed and planted in the houses in their final positions 10 by 10 in. apart during late October and November when the plants are about twelve weeks old. Cutting takes place from March to April. Favourite varieties are Wheeler's Tom Thumb, Golden Ball and All the Year Round.

The Sussex growers in the Worthing district produce large quantities of lettuce in unheated houses, and are of course favoured by climatic and soil conditions. Plants are raised by successive sowings in boxes, the seedlings being pricked out in the borders at 3 in. apart each way. When the plants are about 4 in. high two out of three rows in each direction are lifted carefully so as to thin out the remainder to 9 in. apart each way. The lifted plants are transplanted to other borders at 9 by 9 in. apart. The following sowings are made:

Feltham King. Sown October, planted to final positions at end of January and in February, cut about April.
May Queen. Sown end of February, planted to final positions at about end of March, cut about May.

Any surplus plants from the February sowing are planted out of doors to give a crop in June.

The following varieties are recommended for unheated glasshouses:

For cutting in early spring, March and April:
- * All the Year Round.
- Wheeler's Tom Thumb.
- Harrison's Excelsior.
- * Golden Ball.
- May King (*syn.* May Queen).

For cutting in late spring, April to May:
- * May King.
- Feltham King.

(N.B.—Favourite varieties are marked *.)

Radishes. This crop cannot be grown successfully under conditions of poor light. It does not like excessive heat and must have ample ventilation. For glasshouse production of radishes it is therefore advisable to use light, airy houses provided with ample ventilation (e.g. "aeroplane" houses are very suitable).

Districts where fogs and very dull periods are prevalent are unsuitable for early radish growing. The soil should be light, with a high humus content and not very stony. Such a soil can be well consolidated without becoming hard and "solid" and will retain moisture well. Under these conditions radishes grow quickly and good quality crops are obtainable.

In glasshouses radishes are usually sown as catch crops between the major crops, tomatoes and chrysanthemums. Sometimes successive crops are grown instead of chrysanthemums. Small spaces are often sown as space becomes available. The crop takes from six to nine weeks to mature, according to variety and weather conditions.

The seed may be sown thinly in drills 3 in. apart, as required, between November and April. Alternatively, they may be broadcast in beds of not more than 5 ft. width for convenience in weeding and pulling. The seeds should drop about 2 in. apart, and should be covered with light friable soil from the spaces between the beds. This is usually done by "casting" the soil with a spade (see p. 168), but soil may be sifted on to the seeds if preferred.

Watering is not usually necessary for the winter crops, but as spring advances water will be required in increasing quantities, and should be applied with a fine rose unless overhead irrigation under good pressure is available.

Heating is seldom applied, but quicker growth can be obtained when temperatures of between 50° and 55° F. are maintained. Higher temperatures (unless by sun-heat) should be avoided, or the plants will "run to leaf" and fail to form good plump roots.

Ventilation must be given freely on all favourable occasions, particularly when the seeds have germinated.

Pulling and Marketing. Pulling must commence while the radishes are still young and before they become pithy or hollow in the middle. Sowings are usually arranged so that the bulk of the crop is ready in March and April. Several pullings are made from each sowing, continuing over a period of about fourteen days. They are tied with raffia or fillis just above the roots, in bunches of two or three dozen, washed, usually by dipping in a tank of water, and packed for market in boxes containing two or three dozen bunches. The foliage is left intact. Radishes may also be grown with lettuces or carrots.

Varieties: French Breakfast Forcing, Sparkler Forcing, Glowing Ball Forcing, Short Top Forcing.

Mustard and Cress.* A useful salad crop known in the trade as "Hot and Cold". It can be grown all the year round in glasshouses and frames, and during summer out of doors, but it is in greatest demand in winter and spring when lettuces are not plentiful. It can be a profitable sideline for the retailer-grower providing he maintains a constant supply when in demand. When grown for the wholesale market the crop is seldom really profitable unless grown on a large scale, as is done by certain specialist growers particularly in Lancashire and in the Worthing district.

Frame production follows the same general lines as that produced in glasshouses.

Cultivation. Commercially, nearly all the mustard and cress is produced under glass. The seed is usually sown in glasshouse borders or beds or in frames, but on a small scale it can conveniently be grown in shallow boxes or in seed trays. The soil must be rich and light in texture, for quick growth is essential for the production of tender, first-quality crops. Such a soil is often available after a cucumber crop, and on a large scale mustard and cress is often grown in cucumber houses as a catch crop between a crop of chrysanthemums and cucumbers, or between two cucumber crops, during winter and early spring. Following a cucumber crop the soil is very rich in humus, easily worked and very fertile.

Soil Preparation. When grown as a catch crop following cucumbers the soil is dug over and raked thoroughly so that a very fine tilth is made and all lumps are broken down. No fresh manure is added, as this is frequently harmful to the crop. The surface is made firm by beating with the back of a spade. If the soil has to be prepared (e.g. for box cultivation) a compost is made containing loam, sand, leaf-mould or peat, and a little superphosphate to assist rapid root action. The soil is firmed with wooden pressers and some growers press the seed into the soil also. Sometimes a layer of leaf-mould is put on top of the soil; the seed is sown on the leaf-mould and the seedlings grow clean and free from grit. Whether grown in boxes or in glasshouse borders, etc., the soil must be of the right degree of moisture. It must not be sodden, but must contain enough moisture to carry the crop through to marketing time (this is generally ten to fourteen days after sowing), as overhead watering is not desirable. The atmosphere should be humid but not stagnant, and a uniform temperature of 55° to 60° F. should be maintained. Some growers prefer 60° to 65° F.

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* Mustard—*Sinapis alba;* Cress—*Lepidium sativum.*

Seed Sowing. Mustard germinates more rapidly than cress and should therefore be sown three days after the latter. Rape (*Brassica rapa*) is largely used instead of mustard, as it is cheaper and does not go soft rapidly in hot weather. It is a common practice to sow some mustard seed on top of the rape three days after sowing, as this is said to improve the flavour of the salad. (One gallon of mustard seed to three gallons of rape.) This is only done during the cooler months of the year. Rape germinates at about the same rate as cress and so can be sown at the same time.

The seed is sown very thickly, either directly on to the soil or leaf-mould, or after previously placing thoroughly damp coarse-mesh sacking on to the soil. The object of the sacking is to prevent the seedlings carrying up grit and soil during their growth. A good crop can normally be obtained by sowing at the rate of approximately 1½ lb. of cress or rape seed to every 4 sq. yd., or 2 lb. of mustard seed.

With either method the seeds must not be covered with soil, but since they germinate best in darkness opaque paper or sacking should be spread over the boxes or beds, or over the frame lights. These coverings are removed when the seedlings are about 2 in. high and the seed-leaves are throwing off their seed-coats. It is then "finished" in the light in order to develop a good green colour.

Gathering and Marketing. The crop is ready to cut in about ten days during spring and fourteen days during winter, from the time of sowing. A long sharp knife is used and the work requires some skill as all grit and soil should be excluded, and the seedlings cut with the maximum length of stem. A handful is cut and immediately placed upright in a punnet. The punnet for cress is smaller than that used for mustard or rape. Punnets containing both "hot" and "cold" are marketed by some growers. These punnets are packed into wooden crates containing three or four dozen punnets.

Clearing the Ground. Mustard and cress is shallow rooting and the ground is cleaned by removing the top 1 or 2 in. of soil together with the "stubble". The soil is then dug and prepared as required for the succeeding crop.

Small retailer-growers often produce the crop in shallow seed trays from which the salad is cut fresh as required by customers.

Chapter Eleven

Separate Salad Crops

Beet (Red Beet or Beetroot) (*Beta vulgaris*). There is quite a good demand for early young beetroot for salad purposes, particularly during June and July.

Varieties. The only kind extensively used for this purpose is the round or turnip-rooted type, of which there are several good varieties and strains. Among these the following can be recommended: Crosby's Egyptian, Early Model Red Globe, Detroit Dark Red Globe.

Soil. The best quality beet is grown on light sandy but fertile soils. On heavy clay soils growth is too slow, with the result that beetroot of poor quality are produced and early sowing and harvesting is impossible. The land used should not receive fresh dung, but should have been well manured for the previous crop. A complete artificial fertilizer, consisting of 4 parts sulphate of ammonia, 8 parts superphosphate, and 4 to 6 parts sulphate of potash, applied at the rate of 5 cwt. per acre during the spring preparation of the soil, is often well worth while. If the soil is deficient in lime this should be added liberally. This crop does not thrive on very acid or stony soils.

Seed Sowing. Unless the soil, local climatic conditions and site are particularly good, beetroot should not be sown out of doors until March for pulling in June or July. (Main crops are not sown until April or May.)

Beetroot is rather a tender crop, and for this reason it is wise to sow thickly, and to make two or three successive sowings where possible. Excessive wet or sharp frost frequently does considerable damage to very early sowings. From 12 to 16 lb. of seed per acre are required. Rows should be 15 to 18 in. apart. The seedlings are thinned to about 1 in. apart when only a few inches high, and are later finally thinned to 2 or 3 in. apart. Over-thinning tends to the production of coarse roots.

Forcing Beet. Beetroot will not stand hard forcing conditions, but will respond to a gentle hot-bed. A good compost may be made of loam, leaf-mould or peat, and sand, to which some superphosphate and sulphate of potash have been added. Sowings are made successively in the frames from mid-January onwards. The rows should be 10 in. apart and the plants thinned out as early as possible to 2 or 3 in. apart. Great care must be exercised in watering as too dry or too wet soil conditions are fatal. It is necessary to ventilate freely on all favourable occasions. The lights may be taken off on warm dry days as the plants grow taller, finally removing them altogether.

Marketing. Salad beet is marketed in bunches, the tops usually being retained. Each bunch contains from 3 to 12 beet according to the preference of the particular market concerned. The beets should be graded as bunched, the ideal size being 2½ to 3 in. diameter. They are frequently marketed in returnable bushel boxes, but for long-distance transport non-returnable lettuce or cauliflower crates are preferable. Packing and handling must be done with care as beetroot readily bruise and "bleed".

Celery (*Apium graveolens* Linn). Celery growing in frames has been discussed in the chapters on French and Dutch gardening; the following notes deal with out-of-door cropping on a large scale.

The wild form of celery is found in Britain, Europe and other temperate regions, generally growing in marshy places and ditches near to the sea coast.

The garden form has been grown by the French since early in the seventeenth century, and is now cultivated in most countries and used both as a salad and as a culinary vegetable. Celery is also canned for cooking purposes.

Celeriac is a turnip-rooted hybrid but it is not popular in this country.

Cultivated celery requires land with a high water-table, but it does not thrive on water-logged soil, although the wild form is found on marshes.

The popularity of the crop has increased considerably since the end of the Great War, and it appears likely that the demand will tend to increase still more. In 1934 the area of celery grown in England and Wales was 7,510 acres, whereas in 1918 only 2,996 acres were devoted to the crop. It is nearly all consumed as a salad during autumn and winter. The chief celery-growing counties are Cambridgeshire, Huntingdonshire, Lincolnshire (particularly the Isle of Axholme), Lancashire (moss lands), west Norfolk and West Suffolk. Although grown in all parts of the country in private gardens, this crop is not widely grown by market gardeners in general. It is a specialized crop that demands certain conditions of soil and climate, if it is to be profitably produced commercially. These conditions not only affect the quality of the crop but also the cost of production.

Climate. Celery thrives under conditions that provide frequent showers in the early part of the season to keep the young roots moist, followed later by warm sunny weather when the roots are sufficiently developed to obtain water from the soil.

Soil. The best soils for commercial celery production are deep but easily worked, rich in humus or organic matter, usually acid, and—most important of all—possess a high water-table.

The black fen-land soils of Cambridgeshire are typical celery soils, but in the Isle of Axholme (Lincolnshire) good crops are produced on different types of soils, including "warp" lands, all of which, however, are similar, in that they possess a high water-table.

The "warp" lands consist of a soil built up by means of a system whereby the land is repeatedly flooded with water from a tidal river, the sediment allowed to settle each time, and subsequently the surplus water drained away.

The typical "black-land" soil offers many advantages over the loamy types of soil, although the latter often produce crops of better quality. The "black lands" produce early crops and heavy yields. They possess a high water-table and are easily worked at all times. The process of moulding up the plants for bleaching purposes can readily be carried out, and the celery heads wash well and present an attractive appearance on the market.

Rotation. When grown on a large scale celery is usually preceded by a cereal or root crop and followed by potatoes. Celery leaves the land in excellent condition for potatoes, but too rich in nitrogen for cereals.

Cultivation and Manuring. As a rule 20 to 30 tons per acre of farmyard manure should be applied when preparing the land for celery, although smaller quantities are sufficient for some of the rich "black lands". The manure is best collected and stacked in the autumn, and applied to the land in spring, or in March to the "warp" lands, and in May to the black lands. As a rule, deep trenches are made with a digger plough, into which the rotted manure is placed, and then covered over by ploughing again. Fertilizers must be added at the same time, particularly phosphates, which are usually applied in the form of superphosphate at the rate of 4 to 6 cwt. per acre. Complete fertilizers are also applied, especially when farmyard manure is omitted. Mr. A. H. Hoare, an authority on vegetable manuring,* has recommended the use of a complete fertilizer showing a 4–10–6 analysis, i.e. each 100 lb. of mixture contains 4 lb. nitrogen, 10 lb. phosphoric acid and 6 lb. potash, for peaty soils, or a 5–10–5 analysis for loamy soils. The quantity to be applied depends upon the amount of farmyard manure applied, but varies between 1,000 and 1,500 lb. per acre.

Subsequently, on some soils, top dressings of sulphate of ammonia are given in three applications of 1 cwt. per acre each. The first dressing should be given at the second earthing-up, the second and third dressings at three-week intervals. Some growers apply the first dressing before earthing-up commences. Such nitrogenous manures must not be used indiscriminately, as excessive amounts encourage the growth of "pithy" celery and probably make the plants more susceptible to disease.

Raising the Plants. The seed may be sown either in cold or warm frames. The latter are warmed by hot-beds, made about 1 ft. deep and covered with 3 in. of good soil, sifted through a ½-in. riddle. Very high temperatures are undesirable and if too much heat is generated, the frames are left open for a day or two before sowing. Cold frames are also used extensively for raising seedlings, especially for the main crops,

* A. H. Hoare, *Vegetable Crops for Market*, Crosby Lockwood, 1937, p. 138.

and are preferred by many growers, since they produce sturdy, hardily grown plants that suffer little check when planted out of doors. On the other hand, seedling raising in heated frames is less dependent on the weather and early batches may readily be grown.

Whichever method is adopted, the soil should be sterilized before seed sowing, unless it is possible to use good, fresh garden soil, known to be free of celery diseases and pests. Sterilization is effected by watering the soil with a 2 per cent solution of formalin (1 pint of formalin to 6 gallons of water) at the rate of 4 gallons of solution to a 6 by 3 ft. light. The soil should be covered afterwards with sacking previously soaked in formalin, then the lights put on and kept closed for two to three days. Subsequently, all trace of the fumes must be dispersed from the soil by opening the frames and stirring the soil with sterilized tools each day for a fortnight. It is possible for the leaf-spot disease to be carried on the seed and partially sterilized or treated seed may be obtained from most seedsmen. Seeds may be treated for the leaf-spot disease by soaking it for periods up to 24 hours in a solution made of 1 part of formalin (= 40 per cent formaldehyde) to 400 parts of water. This treatment reduces but does not eradicate the disease.

The best way in which to obtain clean seed is that of growing specialized seed-bearing plants that have been kept free of disease throughout their lives by repeated sprayings with Bordeaux mixture.

Sowing. Seed may be sown in warm glasshouses or heated frames in January or early February, or in cold frames from mid-February onwards. Most growers sow the bulk of their crop in February. About 1 oz. of seed is sufficient for 2 lights (approx. 6 by 4 ft.) and should produce about 25,000 to 30,000 plants (1 oz. of seed contains 50,000 seeds). It is usual to sow 1 oz. of seed for each acre to be planted. To facilitate even sowing the seed is often mixed with whitening. After sowing it is just covered with sifted soil to protect it against the heat of the sun.

"Chitting". Some growers "chit" or germinate the seed before sowing it in cold frames, as it is claimed that "chitted" seed is less likely to rot in the cold soil, and comes up quicker. Seed is mixed with a little fine sifted sand and then soaked in

water. Afterwards it is spread out in boxes placed in a glass-house or frame in a moist atmosphere at a temperature of 70° F. As soon as the seeds "sprout" or germinate they are dried off enough to handle, sown evenly and thinly in the frames and lightly covered with sifted soil. This method is not popular with all growers, since germination usually takes place readily in heated frames.

The soil must be kept constantly moist, neither too wet nor too dry. A very fine rose must be used for watering. Ventilation must be given, particularly on sunny days, as soon as the seedlings come through (approximately 5 to 6 weeks in cold frames, and 2 to 3 weeks in hot-bed frames). If the frames are kept closed weakly plants are produced, and also a humid atmosphere may be formed, thus encouraging disease. In order to encourage root formation at the base of the stem and the development of "stocky" plants, the seedlings may be top-dressed, when they are ¾ to 1 in. high, with a mixture of one spadeful of old soot to one barrowload of sterilized soil. The seedlings must be hardened off by gradually increasing the ventilation and removing the lights entirely for the last 10 to 14 days before bedding out.

Bedding Out. This work generally takes place from the end of March to mid-April. The hardened seedlings are transplanted 1½ to 2 in. square into well-prepared soil in long beds 5 or 6 ft. wide. In transplanting, the tap-root is damaged or broken, and this is advantageous since it encourages the formation of a cluster of fibrous roots instead.

Pests and diseases must be carefully controlled by routine sprayings, particularly during damp, muggy weather, when disease is likely to spread rapidly.

Final Planting Out. This usually takes place in June, during showery weather if possible, when the plants are about 5 in. high. They are lifted with a spade and placed in potato chitting trays ready to be taken out to the planters. In commercial celery growing the plants are planted out on the "flat" and not in trenches as in small gardens. Just before planting the land is harrowed to form a fine tilth. The plants are set out 4½ in. from each other in rows 5 to 5½ ft. apart (i.e. 18,000–20,000 per acre). In certain districts (i.e. in Lancashire) the spaces between the rows are used for growing early maturing crops, such as lettuces, peas, and some Brassicas. Planting is done in several ways according to the district. On the heavy "warp" lands, four workers co-operate. The first marks the rows with his foot, the second makes holes with a "poy" or "dibber", the third drops the plant beside the hole, and the last man sets and firms the plant. On lighter lands, a trowel is used instead of a dibber. Watering-in after planting is only necessary if the weather and soil are dry at the time.

Routine Cultivation. Horse-hoeing between the rows, and hand-hoeing or hand-weeding around the young plants, is important summer work. According to the weather, three to eight spraying applications may be necessary, to keep down disease. A top dressing of sulphate of ammonia at 3 cwt. per acre may be applied in July when the plants are about 15 in. high and have been earthed up twice. Earthing-up is practised by various methods in order to bleach the celery, and it is repeated from time to time. A digger plough is the most popular tool for the first banking up, which takes place when the plants are about 7 in. high. Later, a special celery-moulder is used, and the final work of packing soil around the plants is effected with spades.

Lifting and Marketing. White celery is the earliest to mature and on light sandy soils harvesting begins at the end of August. The celery is fit for marketing when the outer stems are well bleached for at least a third of their length. Unbleached produce only does harm to the trade.

The celery is graded into two sizes and twelve sticks are tied to form a fan-shaped bundle. Alternatively they may be packed unbunched in crates, size 18 by 15 by 4½ in., holding 12, 18 or 24 selected, graded and trimmed celery sticks. Mr. J. G. Murray, the Horticultural Instructor for Lindsey, organized several experiments in the Axholme area, to improve the "market presentation" of celery, by washing, grading and cleaning, before packing. The bulk of the celery grown in the field is marketed loose, unwashed, but some growers are now finding that it pays to wash and tie. Washing machines are now in use and are capable of washing 50 heads per minute, or the produce of half an acre per day.

Varieties. The quality of celery is considerably affected by cultivation and manuring, and it is also very important to select good strains of varieties for market. The two chief groups are the White and the Coloured (Reds and Pinks).

The White Group. These are the earliest but also the most susceptible to frosts. Typical varieties include:

For Black Soils

Dwarf	White Gem.
Intermediate	Sandringham.
Tall	Solid White. White Manchester.

For Heavier Soils (i.e. Axholme area [Lincs])

Dwarf	Biddy's Defiance.
Tall	Blundell's Giant White. Clucas' Special Market White.

The Coloured Group (Reds and Pink)

Clayworth Prize Pink.
Ball's Pink.
Clucas' Preston Pink.
McHattie's Prize Red.

Many other varieties are favoured in the different celery-growing localities, partly for their general suitability from the grower's point of view and partly because of local market requirements (as to size, flavour, colour, etc.).

Chicory (*Cichorium intybus*). This plant is cultivated on a large scale for its root, which, when dried, roasted and ground, is extensively used for mixing with coffee. For this purpose the Brunswick Chicory and the Magdebourg Chicory are used. The former is useless for salad purposes, but the Magdebourg type produces a loose head of leaves known as Barbe de Capucin (Monk's Beard) which is used extensively for salads in France. About 600 tons of chicory are imported into this country annually, mainly from Belgium, and its popularity is undoubtedly increasing.

Witloof Chicory. The most popular type in this country is the Witloof (or White-leaved) Chicory. It may be used as a vegetable or as a salad, and possesses an excellent flavour and certain medicinal properties. In this country it is cultivated chiefly for market in Cambridgeshire, Huntingdonshire and in the Home Counties. Belgian market gardeners are the leading growers of chicory in the world, and their methods are described in the *Journal of the Ministry of Agriculture* for August, 1925, by Professor O. F. Wuyts. In the same journal for May, 1936, is given an account of a method of commercial chicory production in Lincolnshire by J. C. Wallace.

Cultivation. A light fertile soil is desirable. It should be well manured by autumn dressings of farmyard manure, superphosphate and sulphate of potash. Many growers prefer to use land that has been well manured for a previous crop. In any case it must be deeply moved and the surface worked down to a fine tilth. The fen land is a very suitable medium for this crop.

Sowing. It is important to secure a good strain of the correct variety. The seed is sown with a drill in late May or June, ½ in. deep in rows 1 ft. apart. The seedlings are thinned out about six weeks after sowing and again three weeks later, leaving the plants 8 or 9 in. apart in the rows. Hoeing must be done as soon as the young seedlings appear and should be repeated at intervals as long as growth permits.

Lifting and Storing the Roots. Between the end of September and mid-November the roots may be lifted by means of the spade, fork or plough. If they are to be forced immediately, the leaves are cut off 1 in. above the crown as lifted. The roots are then placed in shallow layers out of doors or in a shed for two to five days to allow them to dry and so check growth. When stored for forcing later, the leaves are not removed. They may be stored, as at Kirton, Lincs, by laying them in deep furrow or trench, and ploughing back the soil over the roots. In frosty weather, straw, or more soil, may be placed on top of the leaves. Alternatively they may be stored by placing the roots upright in a clamp surrounded by soil, protecting them in frosty weather with sacking, leaves or straw.

In America satisfactory results have been obtained by storing at a temperature of 31° F. Chicory roots do not freeze at temperatures above 28° F.

Preparing Roots for Forcing. Medium-sized roots of 1 to 1¾ in. in diameter are chosen if possible, as larger roots produce split double heads and small roots produce poor chicons. Fanged roots are also unsuitable for forcing. The foliage is cut off about 1½ in. above the crown and the roots shortened to a uniform length of 8 in.

Forcing: Out of Doors. Trenches or pits are opened 1½ ft. deep and 5 to 7 ft. wide. A few inches of loose soil are placed in the bottom of the pit, and into this soil the roots are pressed about ½ in. apart from shoulder to shoulder in rows 1 in. apart. The interspaces are filled with soil and the roots watered in. They are then covered with about 8 in. of light, dry soil, having been previously protected from the autumn rains. Sand is not so suitable for this purpose as it works between the leaves of the chicons and cannot be completely washed out (as the chicons are usually cooked whole). The covering soil must not be wet, as the chicons must not be washed before marketing; nor should the soil be excessively rich in organic matter, as this tends to cause rotting of the chicons.

On top of this soil a layer of farmyard manure or horse dung is placed to a depth of 12 to 24 in. and some is placed at the sides of the trench also. Pig manure is unsuitable as it may cause rotting of the chicons. The pit or trench is then covered with corrugated-iron sheets or wooden hurdles with straw on top to retain heat and keep off rainwater. The open ends also are filled with straw. A temperature of between 58° and 68° F. is generally produced and maintained; thermometers are placed on a level with the crowns of the roots. At Kirton it was found that at a temperature of 60° F. the chicons were ready for market in from three to four weeks. For cutting in April or May, roots may be placed in the pits in January without farmyard manure.

Portable boilers for heating hot-water pipes are used out of doors in Belgium, the pipes being placed on the soil covering the roots. A temperature of 70° F. is considered ideal for growing good quality chicory, and at this temperature they are usually ready for market in 18 to 21 days. The soil must be well drained for these pits.

Forcing in Glasshouses or Sheds. In Belgium glasshouses provided with overhead hot-water pipes are used for forcing chicory from October to March.

In this country growers find that sheds are satisfactory. Private gardeners often force roots under glasshouse staging or in frames provided with bottom heat.

Gathering, Packing and Marketing. When about 6 in. long the chicons are ready for removal. When forced out of doors they should be gathered just before the tips push through the covering soil into the manure. After removing the straw, hurdles, etc., at one end of the pit, a trench is dug to the depth of the roots. The roots are then lifted with a fork. The crown is separated from the root by a sharp twist. Outer, discoloured leaves are removed, but the chicons must not be washed, though they may be polished with a soft rag. The roots are discarded after forcing. The chicons are usually graded into two sizes, the better of which consists of compact chicons 6 to 8 in. long. They are packed in horizontal rows with the points inwards in baskets or boxes lined with grease-proof or "pale blue sealing" paper, holding 12 lb. of chicons. Each layer may be separated by a sheet of grease-proof paper. Tomato boxes and 14-lb. plum boxes are often used for packing. In the article previously cited, Wallace gives costs of production, and the returns obtained under the conditions of the Kirton experiment.

Barbe de Capucin Chicory. This variety forms a loose head of leaves and is not popular in Great Britain. In France it is grown considerably. Seed is sown out of doors in July and August in fertile soil in rows 1 ft. apart. The plants are frequently hoed and are thinned out twice. In November the roots are lifted, trimmed and tied in bundles. A frame, shed or cellar in which a temperature of 60° to 70° F. can be maintained, is used for forcing. They are packed closely together in soil and covered with 4 to 6 in. of sand and well watered.

Chives (*Allium schœnoprasum*). The leaves of this native perennial are used instead of young onions for salads and soups.

Propagation is usually effected by division of the clumps, the tufts being transplanted 6 in. apart in rows 12 in. apart.

Chives can be grown in almost any soil. Frequent hoeing is essential and top dressings of soil or compost are sometimes applied.

The plants should be divided every three years, planting on fresh ground. This work may be done in spring or autumn.

Corn Salad or Lambs Lettuce (*Valerianella olitoria* (English); *V. eriocarpa* (Italian)). The species mentioned above are the wild forms from which the cultivated forms have been derived. This salad is very popular on the Continent and is used in this country mainly by restaurants and hotels. It is easily grown and forms a useful substitute for lettuce in the winter, as it is quite hardy.

Cultivation. Sowings may be made every week from the end of July until the end of September, to provide supplies during the autumn, winter and spring. Seed can also be sown from March to the end of July for late spring and summer crops. It grows best on land that has been well manured for a previous crop, no further manuring being necessary. A good tilth should be developed and the land well consolidated by rolling and treading. Seed should be sown thinly in drills 9 or 6 in. apart. The former distance is preferable, and 4 lb. of seed are sufficient for an acre at this distance. Showery weather is desirable at sowing time as germination is sometimes irregular.

Drilled corn salad should be hoed frequently to keep down weeds and to conserve moisture. It may be necessary to water the earliest sowings during the summer months.

Cutting and Marketing. The whole plant is cut off level with the ground and all damaged and discoloured leaves are removed. Alternatively the leaves may be picked off separately or in tufts as with spinach. It is packed in chips or hampers.

Cress, American (*Barbarea præcox*). In America this plant grows wild by the side of brooks, and is perennial. It is used for the same purposes as our watercress, but it can be grown in the garden providing that the soil is moist and preferably light in texture. It may be sown each month from March to September to produce constant supplies. The spring and summer sowings are made in shallow drills 9 in. apart, thinning the plants later to 4 in. apart in the rows.

For winter supplies the seed should be sown in September and the seedlings transplanted or thinned out to 3 or 4 in. apart, protecting the plants in severe weather with cloches or litter. Watering is necessary in dry weather.

The crop is gathered by taking individual leaves, or by cutting over the plants, but not too closely to the ground.

Cress, Indian (*Tropæolum majus*). This is the common garden "nasturtium" of which the young leaves, shoots and flowers are frequently used in salads. The fruits and flower-buds if gathered when green and pickled in vinegar form a good substitute for "capers".

Seed is sown 1 in. deep and 4 in. apart in drills 10 to 15 in. apart.

The plants should be staked like climbing peas.

Nasturtiums like a rich light soil with a south aspect.

Dandelion (*Taraxacum officinale*) (Fr. Pissenlit). The blanched leaves of the cultivated variety of dandelion are very popular in France as a salad. The crop is easily grown and has been successfully produced on soils of a light or chalky nature.

Out of Doors. Seed is sown in moist, well-cultivated soil in March and April in shallow drills 15 in. apart, and the seedlings are thinned to 12 in. apart. The ground is kept well hoed throughout the summer. The following spring, as soon as growth begins, the plants may be covered with about 4 in. of sand. The bleached leaves are cut as soon as they appear above the sand.

Forcing Out of Doors. Seed is sown in a seed-bed in May or early June. Six weeks later the plants are transplanted 4 in. apart in trenches 5 in. deep and 2 ft. apart. Watering is usually necessary to prevent the plants from bolting. The ground is frequently hoed throughout the summer, and in November the old leaves are cut off. A ridge of soil is then made over the plants, and hot-bed material consisting of manure and leaves is added on top. Cutting begins after about one month.

Forcing Indoors. Seed is sown in a seed-bed in March or April, and after two months the plants are transplanted 4 in. apart in shallow furrows 1½ to 2 in. deep and 1 ft. apart. During autumn and winter batches of plants are lifted for forcing. The leaves are cut off and the roots trimmed without damaging the taproot. The roots are forced in a dark shed or cellar where the temperature can be maintained at between 60° and 70° F. They are packed closely together in light soil and the crowns covered with 4 to 6 in. of sand. Watering is done frequently. The blanched leaves soon appear, and are ready for cutting in 15 to 18 days.

Varieties. Improved Thick-leaved (Pissenlit amélioré à cœur plain). Suitable for outdoor cultivation and indoor forcing.

Suttons' Broad-leaved or Improved Giant (Pissenlit amélioré géant or Pissenlit chicoré), very suitable for forcing.

The common dandelion is not often cultivated.

Endive (*Cichorium endivum*). Although an important salad crop on the Continent, there is only a limited demand for endive in this country. It is grown chiefly as a substitute for lettuce in the autumn and winter, but although it can be produced in the spring and summer, the public will not buy endive freely when lettuces are available. However, from November to April considerable supplies are on the market, including appreciable quantities from France, Spain, Belgium, Italy and the Netherlands.

Varieties. There are two main types:

(*a*) Moss Curled or Staghorn Endive, with very much branched leaves.
(*b*) Batavian or Broad-leaved type, with undivided but wavy leaves.

Among the varieties suitable for cultivation in this country are the following:

(*a*) *Moss Curled.*

(1) *Ruffec Green Curled*, relatively hardy and grown out of doors in Cornwall, where it seldom needs protection. It forms a large plant measuring 18 to 21 in. in diameter.

(2) *Staghorn or Rouen*, which requires protection from frosts. The leaves are very finely divided and form a large plant.

(3) *Green Curled Summer and Green Curled Winter* Endive, which require protection from frost.

(4) *Moss Curled* is most suitable for forcing and forms a small compact plant 8 to 12 in. in diameter. The leaves are very finely divided and curled. It is, however, not very hardy.

(*b*) *Batavian or Broad-leaved.*

(1) *Broad-leaved Green or Round-leaved Batavian*, very popular in the Home Counties, particularly for autumn cutting.

(2) *Suttons' Winter Lettuce-leaved* Endive, a variety intermediate between Curled and Batavian types. It is vigorous and very hardy, seldom requiring protection.

Cultivation. For cropping in the autumn, the Staghorn and Green Curled Winter Endive should be sown in early and mid-July, followed by successive sowings of the hardier Ruffec and Batavian varieties up to mid-August. It is best to sow the seeds in their final positions, thinning out later, as transplanting frequently checks the plants and causes them to bolt. However, if the seedlings are raised in rich moist soil over bottom heat and carefully lifted and transplanted when very small, they seldom bolt. When sown in final quarters the rows should be 12 to 15 in. apart and the seedlings thinned to stand 12 to 14 in. apart in the rows. Frequently the seed drills are watered before sowing, and where overhead irrigation is available the whole area may be watered. The soil must be well drained and preferably a light loam, rich in humus.

Blanching. It is useless to market endive that is not properly blanched, as when green the leaves are bitter. The plants are ready for blanching when nearly mature—usually about twelve weeks from the time of sowing. In early autumn the blanching process takes about five to ten days, but in winter three weeks may be necessary. Two methods are in use:

(*a*) Blanching in the beds where they grow, by tying up the leaves like a cos lettuce, or by covering with pots, slates, litter or hay. Tying or covering must be done when the leaves are quite dry or rot will set in. They may also need protection from frosts.

(*b*) Lifting the plants before the frosts, and finishing them in frames. This method is recommended for all but the mildest climates. The plants are protected from frost damage and are less likely to rot, if carefully handled. The outer leaves are tied up, and the plants are then carefully lifted with a ball of soil at the roots and planted closely together in frames containing moist soil or sand. Both tying and lifting must be done when the plants are perfectly dry. Any damaged or bruised plants should be rejected, as they will rot. After planting the raffia ties are removed and the lights put on. Blocks of wood are placed under the top and bottom ends of the lights so as to allow free passage of air. The plants must never become wet, and during frosty weather the lights are closed, and covered with straw, litter or hessian. Blanching in the frames is usually done by covering successive batches with hay. Supplies are usually in the market from November to Christmas or January.

Forcing. Two methods are available:

(*a*) Sowings may be made in January and February over a hot-bed under glass, just covering the seed. As soon as large enough to handle the seedlings are transplanted to a milder hot-bed. When they are established air is given when weather conditions are favourable. They are tied up and blanched in the usual way for spring sale.

(*b*) Seed is sown out of doors under bell-glasses or in cold frames during early or mid-September. About three weeks later the seedlings are pricked out into other frames or bell-glasses, and in November or December they are carefully lifted with a good ball of soil and transplanted close together into cold frames sloping to the south. By keeping the frame closed tender plants are produced. They must be protected against frost and blanched as usual. The varieties Moss Curled and French Small Green Curled are most suitable for forcing.

Marketing. The heads are cut close to the ground when the plants are quite dry (usually midday). Curled endive is packed in non-returnable lettuce crates, 24 or 36 per crate. Batavian endive is tied like cos lettuce and packed sideways in returnable bushel boxes, usually holding 24 heads. They are not watered before or after packing, as with lettuce, as this encourages rotting.

Lettuce (*Lactuca sativa*). This important crop is cultivated in this country in various ways, in an endeavour to supply the market throughout the year. The production of lettuce in glasshouses, cold and hot-bed frames, and cloches, has already been described in other chapters. It is therefore only necessary in this chapter to describe methods of production of lettuces that mature out of doors, apart from the crop as dealt with in the chapter on French gardening.

Following the frame and cloche lettuce, the earliest crops maturing out of doors are raised in frames or in glasshouses, planted out of doors in the early spring and marketed in May and June. These are followed by lettuces grown from seed drilled directly into the field in successive batches, to supply the market until November. Finally, autumn sowings of winter-hardy lettuces are made in mild districts to provide crops from April to June according to the locality.

Soils. A deep fertile loam is ideal, but good lettuces can be produced on a variety of soils. A good tilth is essential and the soil should be rich in humus or organic matter, as this assists the retention of moisture and improves the quality of the crop. On most soils, particularly those of a light nature, irrigation should be provided, so that during dry weather plants may be watered or the land prepared for seed sowing (see Chapter Four on Irrigation).

Preparation of the Land. Whenever possible lettuces should follow a heavily-manured crop, and one that leaves the land clean. Many growers consider that leeks, harvested in November, form an ideal crop to precede lettuce. This crop does not carry over insect or fungus troubles likely to affect the lettuce; it is deep-rooting and therefore aerates the soil, and the soil is left in good condition, since leeks are usually heavily manured.

It is important to prepare the land for lettuce by deep ploughing and subsoiling, well in advance of seed sowing or planting, to allow for consolidation. In spring the land should be harrowed, disced and lightly rolled. For very early crops it might be worth while hand-raking the land to ensure a good tilth. On a small scale treading is preferable to rolling.

Manuring. In deciding the manurial treatment, the grower must bear in mind the amount of manure given to the previous crop, the general fertility of the land, and the season of cropping of the lettuces.

When grown on land following a well-manured crop, such as leeks, a satisfactory fertilizer mixture may consist of:

4 parts hoof and horn
3 parts superphosphate
or 2 parts concentrated bone phosphates
1 part sulphate of potash

applied in spring at the rate of 6 cwt. per acre.

When the previous crop has not been heavily manured, the land should receive 10 to 50 tons per acre of farmyard manure, ploughed or dug in during the autumn. The smaller quantities of manure could be supplemented by 6 cwt. per acre of an artificial manure, containing:

1 part sulphate of ammonia
3 parts superphosphate
1½ parts sulphate of potash.

If the soil is of a peaty nature as in the Fen districts of Lincolnshire, the superphosphate in the mixture should be increased to 4 parts. On heavy soils, dressings of 1½ cwt. per acre of sulphate of ammonia alone are often sufficient if applied at the last harrowing or raking. Top dressings applied to the plants during the growing season are beneficial when applied judiciously. Sulphate of ammonia, Peruvian guano and nitrate of soda at 1 to 1½ cwt. per acre are suitable, but should not be allowed to fall on the leaves. The process of feeding the plant through its leaves by means of extremely dilute solutionized irrigation water is as yet in the experimental stages.

Raising Plants under Protection. The chief methods by which lettuce seedlings may be raised for early crops may be broadly classed as follows:

(1) Slow, steady growth methods by autumn sowings in cold frames. (Plants raised without heat.)

(2) Rapid growth methods by early spring sowings in glasshouses and heated frames. (Plants raised in heat.)

(1) RAISING PLANTS WITHOUT HEAT.

(*a*) *Pricked-out Seedlings.* Sowings may be made in cold frames during the first weeks in October, using varieties such as May Queen, Hative de Milly, Watkin's and Simpson's No. 2 (cabbage lettuces), and Lobjoit's Green Cos.

About 1½ lb. of seed will be required to produce sufficient plants for one acre. The seedlings are pricked out in the seed-leaf stage, into other cold frames at 1½ in. apart each way. When established, they are grown as

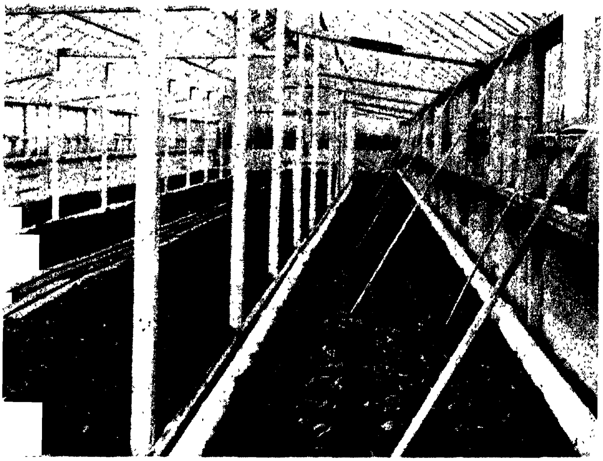

Fig. 28.—LETTUCE (var. Cheshunt Early Giant) growing in a glasshouse at Reading University.

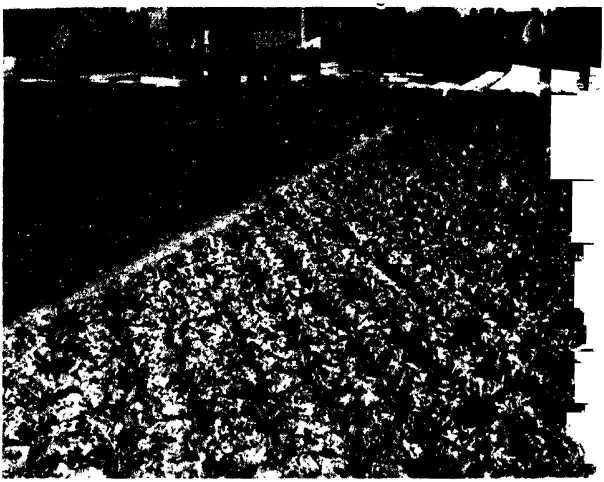

Fig. 30.—INTENSIVE CROPPING OUT OF DOORS. Lettuces (nearly mature and covering the soil) interplanted with cauliflowers.

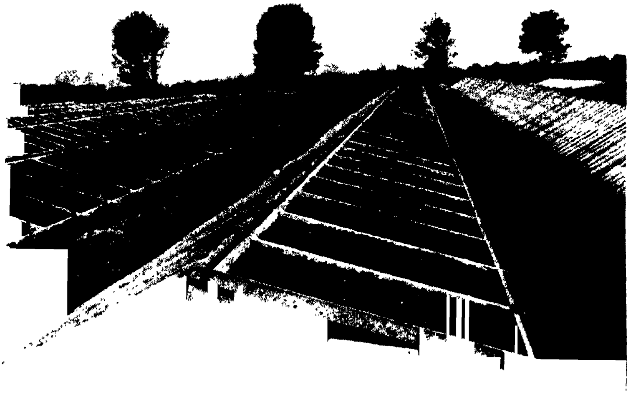

Fig. 29.—LETTUC SEEDLINGS, sow thinly and nc pricked out, ove wintering in th frames. Note stee angle at which th frames tilt towarc the south.

hardily as possible, removing the lights on all favourable occasions, but never permitting the plants to get damp from fog or rain. The method is similar to that adopted when raising seedlings for cropping in Dutch lights, details of which will be found in Chapter Eight, p. 109.

(*b*) *Seedlings Thinned but not Pricked out.* Thin sowings in successive batches during the last ten days in October and the first week in November, in cold frames tilted steeply to the south (Fig. 29). Suitable varieties include:

Cabbage Lettuces: Feltham King, All the Year Round.

Cos Lettuce: Lobjoit's Green Cos.

This system is popular in Middlesex and other parts near London and is said to have originated from intensive gardening methods practised by the Huguenots who settled in the district as refugees about 1685.

Preparation of the Soil. Land should be in "good heart", thoroughly and freely cultivated, but not too rich in nitrogen, and as free from weeds and weed seeds as possible. It should not be too wet, but must hold sufficient moisture to carry the crop through the winter.

Land that has grown leeks followed by four or five crops of radishes should be in a suitable condition.

Erecting the Frames. Frames carrying English or French lights are generally used, but it is probable that they will gradually be replaced by Dutch light frames. The latter have many advantages mentioned elsewhere. Moreover, this system demands the frequent removal and replacement of the lights during uncertain weather, and since the frames are tilted up at a steep angle, the work is somewhat laborious when large heavy lights are used.

The land is marked out in strips running east to west. The width of the strips depends on the type of frame used, but the pathways between them should be at least a foot wider than the lights, to facilitate their removal. Soil is cast up from the pathways to make frame beds sloping steeply to the south, a firm bank about 2 ft. high having been made at the back or north side of the bed.

The boxes or frames are then erected on top of the beds, and the soil further prepared by raking with wooden and iron rakes. About 2 oz. per light of concentrated bone phosphates may be raked into the top soil. Finely-sifted soil is placed on top and levelled off with the back of an iron rake, and with strips of wood about 12 in. long. The production of a good tilth is essential, and all lumps and stones must be removed. Care must be taken when using the boards not to "roll" the soil into small lumps, when endeavouring to make the surface level. A "lumpy" tilth is unsuitable for this work. Finely-sifted soil is placed in heaps in the pathways, in readiness for covering the seed after sowing.

Seed Sowing. An average handful of seed is sufficient for an English light. The sower should endeavour to drop the seeds at about ½ in. apart. Thin, uniform sowing is important, and it may be worth while practising beforehand, using old useless seed or dry salt. The seed is usually sown with a smooth, sweeping movement of the arm. Small handfuls of seed are taken at a time. The fingers are held slightly cupped and touching one another, while the thumb retains the seed in the hand and controls the amount that is allowed to pass between it and the tips of the fingers. Many growers will have their own particular methods of sowing, but the above description of sowing may be useful to the inexperienced. Alternatively, the seed may be mixed thoroughly with about five times its bulk of fine, dry and sterile sand to facilitate sowing.

After sowing the seed is just covered with about ⅛ in. of sifted soil. Nails are driven into the side woodwork of the frames at about 4 in. apart, from which black cotton thread is stretched as a deterrent to birds, which may play havoc with the seedlings when the lights are off.

The lights are put on and kept closed until the seed germinates or "chits". From this stage onwards, ventilation is given as freely as possible on all favourable occasions, night and day. The lights must be taken off entirely whenever the weather permits, by pulling them off backwards into the pathways, but must be replaced to protect the seedlings against severe frost, rain, mist, fog or snow. The seedlings should never be watered. During sharp frosts the lights are kept closed, and even covered with hessian or mats if necessary, but should always be opened again before the sun shines on the frame. Ventilation must be given in rainy weather, but if the rain is accompanied by a driving wind, ventilation must be given on the side away from the wind (the leeward side). The disease known as Botrytis, "collar-rot", "red leg", etc., often seems to originate in patches that have become wet from rain blown in when ventilation has been given, or from drip through leaky lights. When gales are expected, the lights must be secured to the frames; this is usually done by means of strong rope looped alternately through the handle of each light and nails driven in to the outside of the frame woodwork.

The aim should be to grow the plants slowly and continuously without any check, so as to produce strong, sturdy and well-hardened plants ready for planting out of doors in February or March, the actual date depending on the district and season.

(2) Raising Plants in Heat.

(*a*) *In Glasshouses.* In Lancashire and in parts of Kent, this crop often follows chrysanthemums, which are cleared in November. The soil is then deeply dug and left rough and exposed to the weather as much as possible, giving all possible ventilation to the houses until the end of the year. A light dusting of hydrated lime may be worked into the surface. In nurseries where Botrytis of lettuce is prevalent, it is advisable to steam or chemically sterilize the soil. Steaming is usually done while digging the borders, but when chemicals are used the soil is first dug, then raked to provide a good fine tilth and watered with a 2 per cent solution of formalin, applying about 4 gallons per 12 sq. yd. When no trace of the smell of the formaldehyde can be noticed it is considered safe to sow the seed. Whether the borders are sterilized or not, the surface soil must be reduced to a fine tilth and should be sufficiently moist but not wet. In January and February successive batches of seed are broadcast thinly on the prepared beds so that very little subsequent thinning is necessary. The seed may be lightly covered and the surface firmed with the back of the spade. After germination has taken place the house is ventilated freely on all favourable occasions and little or no water is given. The plants should be ready for planting out of doors by mid-March or April. Seed may also be sown similarly in boxes instead of in beds or borders. About 300 seeds are sown in an ordinary seed tray and the seedlings are pricked out into other boxes or in the borders about 14 days later. Suitable varieties include May Queen, Feltham King and All the Year Round, and Newmarket.

(*b*) *In Heated Frames.* Sowings may be made in January or February in boxes, or directly into the beds of heated or hot-bed frames. As soon as the seed-leaves are fully developed, the seedlings are pricked out into other boxes at about 1½ in. apart. Ventilation must be given judiciously, so that steady quickly grown but sturdy plants are obtained. After gradually hardening-off the seedlings, they are ready to plant out at about the same time as those grown in glasshouses (i.e. about mid-March). This method is popular in Somerset and Derbyshire.

Lettuce seedlings may also be raised under French cloches on hot-beds by autumn or spring sowings, or under continuous cloches by spring sowings (see under respective headings).

Planting out Seedlings Raised under Glass. Planting out of doors begins in February with seedlings from the pricked-out autumn frame sowings. In parts of the south of England, a few of these seedlings are planted out in January if the weather is "open". Before the end of February, seedlings from the autumn-sown ranges (not pricked out) are set out of doors. Those raised from January sowings in glasshouses follow in March and April, and into May. In Lancashire, Cheshire and other northerly parts of England, the first plantings are usually made in early March or the last week in February. Cabbage lettuce should be planted at about 12 by 12 in. apart, though this varies in different districts, the rows being marked-out by treading a line. Lines made by drills or "racer" are not suitable, as the plants fail to make a flat base, and become "peaked" and of poor shape. The racer or drill may be used for cos lettuce and these should be planted 14 by 14 in. apart. The soil should not be very wet at planting time, nor should it be frozen.

The plants are carefully lifted from the beds or boxes, all possible care being taken not to break the roots or damage the leaves and stems unduly. They are placed neatly in boxes, in small separate handfuls, and protected by sacking or paper from wind or sunshine, to prevent drying out. A rather bluntly pointed dibber is used for planting, and about 43,000 to 50,000 plants are required per acre. A quick worker can set out 1,000 plants per hour, working piece-work, but although this system is largely used it cannot be wholeheartedly recommended, as it often leads to inferior work. Such work may be satisfactory if good growing weather follows after planting, but if the weather is not so kind, many gaps in the rows may occur. Not more than 100 plants should be held in the hand at one time. As observed elsewhere, seedlings should be set so as to "sit" on the soil, neither too deeply nor too shallow, and the roots should be firmed at the base.

After about ten days, any gaps in the rows, due to Botrytis, slugs, wireworms or other cause, should be filled by planting fresh seedlings, using a variety such as Feltham King which is fairly resistant to Botrytis. "Gapping" or "mending", as it is called, should not be done late in the season, as the replacements develop too late to be harvested with the bulk of the crop. This means that the plants and the labour expended on them are wasted, for if left till they mature the preparation of the land for the next crop is delayed. These early crops are often inter-planted with cauliflowers (Fig. 30).

Routine Cultivation. Subsequently the hoe must be kept going constantly during fine weather, not merely to keep down the weeds but to aerate the soil, and to produce a good surface tilth. Hoeing is extremely important in lettuce cultivation.

Overhead irrigation may be required before the plants are mature, as during drought the leaves become tough and the plants tend to "bolt" quickly. These early crops provide lettuces from mid-May to the middle or end of June.

Spring and Summer Sowings Out of Doors. In most parts of this country crops for marketing between June and November are raised from seed sown directly in the field, but planting-out is practised in districts where the climate is relatively moist (e.g. Yorkshire, Derbyshire and parts of Cheshire). The seed is commonly drilled directly into the field and the plants subsequently thinned out because transplanted seedlings usually run to seed quickly during dry weather as a result of the damage caused to their roots and a general check in growth.

Experiments at the Royal Horticultural Society's Gardens at Wisley in 1919 showed that if transplanted seedlings were watered twice they did not bolt any more rapidly but matured at least a fortnight later than those drilled directly into permanent quarters.

Field sowings are made successively from the middle or end of March to the end of May for the main crops. In the south, if the prevailing weather is good, it is often worth while risking a sowing of cabbage lettuce in February. Seed is also sown during June and July with reasonable success, especially if irrigation is available. In mild districts it is advisable to sow the late summer or autumn crop in a seed-bed about the last week in August, transplanting the seedlings in September. In Hampshire, near the coast, good crops have been produced from direct sowings, made in showery weather or assisted by watering, in the last week of August. In October, when frost may occur, the lettuces are covered with continuous cloches until mature. The variety Improved Trocadero is suitable. Direct field sowings of cabbage lettuce are made in drills 12 in. apart and the plants are later singled to 12 in. apart in the rows, giving 43,560 plants per acre. If the plants stand 9 in. apart in rows 12 in. apart, this gives approximately 58,000 plants per acre, but on good land wider spacing up to 14 by 12 in. is preferable. Cos lettuce should stand 14 by 14 in. apart; and in the south of England the latest spring sowings should be made in April, as it is difficult to produce good crops of these lettuce from later sowings. In Lancashire and in the north, however, cos lettuce sown in May is quite successful.

Seed Sowing. A good tilth is essential, and the land should be reasonably firm before sowing, and lightly rolled afterwards.

The seed is usually drilled in with small hand drills of the Planet-Junior type, which roll the seed-rows in the same operation. If the soil is damp after rain or irrigation it may be found advisable to use a brush drill. In hot dry weather the seed is best sown after the hottest part of the day. About 1½ lb. of seed per acre are required when the drills are 1 ft. apart. When the seed is sown by hand the land may be marked out in drills 1 ft. apart by means of a "racer" or marker. Seed is then dropped in the drills at intervals of 1 ft. and the resulting seedlings thinned to stand singly. By drawing drills in two directions at right angles to one another, the land may be divided into squares, thus facilitating the spacing of the seed. Early sowings may require protection against birds.

Singling. This is usually done with a small swan-necked draw-hoe, the handle of which is about 12 in. in length. This is a handy tool for "close" work of this nature, as the worker is enabled to thin out the plants more accurately than with the long-handled hoe. Singling is done when the seedlings are about 2 to 4 in. high.

Cultivation. Hoeing is probably the most important routine cultivation in early lettuce production. The work should be commenced as soon as the plants are established after planting out or after singling, and should be repeated every 14 days whether weeds are present or not. (For autumn-sown crops occasional hoeings are given when the soil is not frozen or too wet.) Routine hoeing is usually done by hand, using long-handled Dutch hoes, but mechanical or horse-drawn hoes may also be used.

Irrigation. On certain soils and under certain climatic conditions irrigation may play an important part in the production of lettuces. During dry weather irrigation is useful to prepare land for sowing seed or for transplanting, and to assist a growing crop. The objections against overhead watering of lettuces when grown in frames in autumn, winter or spring, do not apply to outdoor summer lettuce.

Cutting and Marketing. Drilled crops require from 8 to 10 weeks to mature during summer, and cutting may extend over a period of from 10 to 21 days, according to the weather and to the variety of lettuce grown. If the weather is cold and dry the crop may mature very irregularly. The whole of the crop is seldom marketable and 75 per cent is considered satisfactory by commercial growers. When transplanted lettuces are produced, up to 90 per cent may be marketed if the growing conditions are good, but the crop takes from 10 to 12 weeks to mature.

All lettuce should be cut early in the morning as they are in better condition for marketing at that time, and keep fresh for much longer periods than when cut in the heat of the day or in the evening. A fairly long-bladed knife, such as a sharp half-worn table-knife, is used for cutting the cabbage lettuce, cutting just above the lowest leaves that lie on the ground.

Each lettuce that appears to be mature is tested by pressure from the back of the hand (fingers) and not squeezed between the thumb and the fingers, because when this is done the lettuces are frequently bruised or damaged by the worker's finger-nails. Alternatively, the left hand may be placed underneath the lowest leaves, with the tips of the fingers together and touching the stalk. The lettuce is then tested by pressing the palm of the hand against the heart. Only mature lettuces are cut, and these are placed face downwards on the soil if it is dry or against an uncut lettuce if it is wet. The packers, usually women, follow behind, and collect the lettuces. They pack the lettuces in non-returnable wooden crates, holding 18, 24, 30 or 36 lettuces, according to the grade. Except for the earliest crops, grading and the removal of diseased or discoloured leaves takes place in the field. The crates should not be paper-lined in summer as this prevents free ventilation. They are taken to the packing-shed and given a good watering before being sent to market.

Cos lettuce are usually tied with raffia about ten days before cutting to assist hearting, even though a self-folding variety be grown. Rubber bands, size 18, may be used instead. Cos lettuce should not be cut as they tend to bleed and wilt rapidly. They should be pulled up by the roots and the soil shaken off, or they may be twisted off, care being taken not to damage the head. They may be packed in large non-returnable lettuce crates, size 2 (2½ by 16½ by 9 in.), or in returnable bushel boxes.

Varieties (*Summer*). Some of the most popular varieties for direct field sowings include: Market Favourite, Trocadero and other similar types, All the Year Round, Feltham King, May Queen, Watkin & Simpson's No. 2, and Newmarket.

Autumn-sown Lettuce. Soil should preferably be a well-drained, light loam, as the seedlings often fail to survive the winter on heavy, wet soils; though good crops have been grown on soils of very light texture, but having a high water-table. Land that has grown well-manured crops that leave the land clean is preferred. Additional manuring may not be necessary, but when doubt exists an application of 2 cwt. of sulphate of potash plus 6 to 7 cwt. of hoof and horn is suitable for working in the top soil. When slugs are prevalent lime should be applied.

Seed is sown on fertile land between the end of July and mid-September according to the local climatic conditions; 1 lb. of seed is sown for each acre to be planted. In October the seedlings are planted out 12 by 12 in. or 9 by 12 in. apart on firm land when the soil is in a suitable condition for planting. The soil should be well up to the lower leaves of the seedlings or frost may damage the surface roots.

Cultivation. Very frequent hoeing is neither possible nor advisable for this overwintering crop, but it should be done twice before Christmas and more frequently during the spring. Rapid spring growth may be further stimulated by the application of a top dressing of sulphate of ammonia or Peruvian guano, care being taken not to allow the fertilizer to fall on the leaves. Seedlings may also be raised by sowing in frames in September and planting out of doors at the end of October or November.

Varieties suitable for mild districts and producing good quality lettuce are: Suttons' Imperial, Lee's Immense and Winter Victor.

More hardy varieties include: Arctic King, Excelsior, Suttons' Arctic, Schofield's Hardy Winter, McHattie's Giant and Hammersmith's Hardy.

Hardiest of all is Stanstead Park, though of rather poor quality.

List of Major Types of Lettuces.

Cabbage Lettuce. The British public favour the types of lettuce classed under the general group of "butterheads", having leaves that appear soft, smooth, oily or buttery in texture. The crisp or curly types that are very popular in America are seldom grown in England, and one of the few varieties that are grown to any extent is Webb's Wonderful, a large white-hearted lettuce with dark green foliage curled at the edges. Some of the chief varieties in the "butterhead" group will be given below in classes or types:

All the Year Round Type. Medium size with puckered dark green leaves forming a heart of good flavour. A valuable variety suitable for most seasons of the year; can be sown in autumn out of doors in very mild districts; and is sometimes grown in cold glasshouses. The following varieties may be considered similar: Suttons' Matchless, Early Market All Heart and All the Year Round Improved (these three being earlier but slightly smaller than the type); Dry Weather (resistant to drought) and Chavigne.

Trocadero Type. An excellent market lettuce forming a good heart with a yellow interior. It is a large, rather hardy lettuce, having light to medium green leaves with a smooth and rather greasy appearance. It matures quickly and travels well. Varieties are Trocadero, Big Boston, Suttons' Ideal, Paragon, Borough Wonder, Market Favourite, May Wonder (useful under glass), Trocadero Improved, Unrivalled, All Seasons and Newmarket.

The first four have leaves with reddish margins and are most suitable for late autumn and winter crops, while the others are wholly green and are suitable for summer cropping in most districts.

Feltham King. A good medium to large comparatively new market variety, which has quickly become popular. It forms a solid compact heart with glistening medium green leaves, and is excellent for early and late summer crops and as a midsummer crop in wet summers. It will succeed during drought weather without readily bolting, but the leaves tend to become yellowish. The French variety Gloire de Nantes is similar.

May Queen Type. A good all-round variety for raising in frames and planting out of doors, or for planting into other frames or cool glasshouses for summer and autumn cropping out of doors, and for overwintering in continuous cloches. The plants are large and spreading when young but later form good hearts. Different strains vary in quality. May King is the same as May Queen.

Winter Hardy Type. Those that stand the normal winter in all parts of England are rather coarse in texture, though when grown in the milder districts they grow quicker in spring and become more tender. Popular varieties are Stanstead Park (the hardiest), Schofield's Hardy Winter White, Yate's White Winter, Hammersmith Hardy and Harrison's Green Winter.

Others that produce rather small lettuces are Excelsior, Arctic King and Suttons' Arctic.

Those that stand normal winters in the milder parts of England (although they are sometimes successful in the colder districts also) include Winter Victor, Suttons' Imperial and Lee's Immense. These are of a much better type and quality for market than the more hardy varieties, but may suffer more from Botrytis. Suttons' Imperial proved particularly good in certain variety trials carried out in the North of England.

In mild climates the Trocadero types will also succeed when overwintered out of doors, especially when protected by continuous cloches during severe weather.

Gotte Types. The variety Gotte à Forcer may be taken as representative of this type. It is essentially a lettuce for frames and glasshouse culture, and it is successful in cold frames when no ventilation is given. The soil must be highly fertile. It grows quickly and hearts well during periods of short daylight hours, but "bolts" to seed very readily if grown during the summer months. It forms a very compact medium-size lettuce, tender, and of a light green colour with a firm heart. The following are generally similar but may differ in size and colour:

Gotte Grise à Coucher; Green Frame and Evergreen; Gotte à Graine Blanche; Loos Tennis Ball, and its mildew-resistant selection "Blackpool"; White-seeded Tennis Ball; Boston Market; Gotte à Coucher à Graine Noire, and its selection Early French Frame; Gotte à Graine Noire (Salamander); Gotte à Chassis à Graine Noire (Early Paris, Paris Market Forcing, Suttons' Early Paris).

Other Varieties for Glasshouse and Frames include Forcing Milly, Golden Ball, Watkin & Simpson's No. 2, Princess, Rosy Spring, Suttons' Favourite, Cheshunt Early Giant and Cheshunt Early Ball.

The variety Cheshunt Early Giant, when successfully grown, is probably the finest variety for early cropping in heated glasshouses, being capable of producing good hearted lettuces as early as December. It bears some resemblance to the Gotte types.

Cheshunt Early Ball is a promising variety for frame cropping, but the seed has not yet been generally distributed.

Cos Lettuce. The demand for this type of lettuce has fallen considerably in recent years. Some varieties need tying with raffia or soft fillis twine to make the heart, while others are self-hearting or self-folding. Growers usually tie even the self-folding type about ten days before maturity or when packing. Cos lettuces have a distinct nutty flavour and when well grown are considered by some people to be superior to cabbage lettuce.

Paris Green Type. Large self-folding, dark green, and very popular on the London markets. Mainly grown from early spring sowings out of doors, or overwintered in frames and planted out of doors in the spring. Varieties include Lobjoit's Green, Paris Green, St. Albans All Heart and Vaux's Self-Folding Green.

Paris White Type. A lighter green than the Paris Green type but popular on some markets. Self-folding and of medium to large size. Varieties are Paris White, Suttons' Superb, Trianon, London White, Sharpe's Standard White and Crystal Cos. There are also some very large varieties—Jumbo Cos, Exhibition, Kingsholme and Alexandra White.

Hick's Hardy White Type. Medium green colour, very hardy, needs tying. It can be overwintered or sown in the spring. Hardy White is similar.

Bath Cos Type. These have medium-size heads and the outer leaves are tinged with reddish brown, making them less suitable for market. Needs tying. Varieties are—Bath Cos, Bath's Black Seeded, or Black Seeded Bath Cos.

Winter Density. Classed by the Royal Horticultural Society as a semi-cos; is intermediate between the cos and cabbage types; dark green in colour; compact but the outer leaves are upright; is not a good market variety as it is rather small; is winter hardy and does not readily bolt.

Bristol Cos and Balloon are other types.

Melons.* The inclusion of some account of the production of melons in frames is necessary, since they can form an important crop in some intensive cropping systems under Dutch lights. The crop does not appear to be very popular with English growers, partly because of the uncertainty of the market demand, and partly because some form of bottom heat is necessary when it is grown in frames otherwise unheated. Moreover, since the frames have to be prepared ready for planting out during the first week in April, it is usually impossible to produce hearted lettuce on the cold system as a preceding crop. The best crops for this purpose are radishes and spinach. It is possible to follow the melons with a crop of cauliflowers planted out during July before the melons are quite mature. These cauliflowers receive little water until the melons are cleared. They may then be copiously watered and should be ready for market in September.

Varieties. For frames heated only by hot-beds the following sorts are suitable:

Early	The Dutch Carbuncle (Carbonkel) Westland Double Net Cantaloups
Mid-season . . .	Orange Ananas
Late	Sugar Melon.

Raising the Plants. Seed may be sown in February in boxes containing a loamy compost to which has been added a little sand, leaf-mould, peat or terreau. A humid atmosphere and a minimum temperature of 65° F. are necessary, and these conditions can be obtained in a heated glasshouse or hot-bed frame.

Seedlings raised in boxes are potted into 3-in. pots, or are sometimes pricked out 6 in. apart into other boxes before potting. Alternatively, the seed may be sown direct into 3-in. pots, half filled with compost, adding the remainder 10 to 12 days later as a top dressing.

The usual precautions against damage from excessive sunshine or from frost are necessary. After germination some ventilation is given, and watering is done carefully and sparingly. Growth should be steady and not too rapid.

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* Melon—*Cucumis melo.*

Preparation of the Beds. Towards the end of March or early April, the frame beds must be cleared of any preceding crops and prepared for the melons. A hot-bed is made with manure or a mixture of manure and leaves in a trench 1 ft. deep by 1 ft. wide, dug out about the middle of the frame along the length of the range. The hot-bed is then covered with soil, which should be made fairly firm. The lights are placed on for a few days before planting.

Planting Out. Two melon plants are set in position side by side over the hot-bed, and watered in carefully. The lights are replaced and kept closed and shaded for a few days until the plants are established. Afterwards ventilation is given in gradually increasing amounts to harden off the plants.

Stopping and Training. Three systems are in common use. In one method the plants are stopped by pinching out the main shoot at the fourth true leaf, soon after planting out in the frames. Four shoots develop as a result, and these are trained one to each corner of the frame. These are also stopped and subsequent sub-laterals are shortened to 2 leaves.

In another method the first stop takes place when the plants are in the pots, the tips being pinched out so as to leave 2 leaves in addition to the cotyledons. As a result 2 laterals develop, and these, after planting out has been done, are trained towards the back and front of the frame and stopped when about 12 in. long. Subsequent sub-laterals are allowed to make about 6 leaves, and then shortened to 3 leaves.

In the third method the plants are set at the back of the frame and the leader allowed to grow towards the front board before stopping. The side-shoots are stopped at two leaves beyond the young fruit.

Selection of the Fruit. Each melon plant produces two kinds of flowers, male and female. The female flowers can be distinguished by a small green swelling or knob at the base of the flower below the petals. The male flowers are more numerous and bear the pollen. The pollen must be transferred from the male to the female flowers in order to induce fertilization. This may be carried out by bees during hot weather, but conditions are not usually favourable for the natural pollination of early crops, and this should be done by picking the male flowers and gently rubbing the pollen to the stigmas of the open female flowers. As far as possible, all mature flowers on a plant should be pollinated on the same day.

In a few days, fertilization of some of the female flowers will be apparent by the enlargements of the green knobs beneath the petals. When these are a little larger than a walnut the best are selected and retained to produce the fruit. The remainder are rubbed out, including any present on the main stem. The number of fruits selected per plant depends upon the variety grown. With the small Sugar Melon an average of 6 per plant is retained; with Orange Ananas an average of 3½ per plant; and with the Dutch Cantaloup type only 1½ fruits per plant are allowed.

Subsequent Management. The fruit-bearing laterals are shortened to 2 leaves above the fruit and other shoots are thinned out periodically. Excessive foliage shades the fruit and tends to exhaust the plant, but over-thinning should be avoided as sufficient leaves must be retained to assist fruit development.

Sometimes a few fruits fail to swell evenly, probably because of imperfect fertilization. If two or three shallow cuts are made with a sharp penknife on the undeveloped side, a compensating stimulus is provided and usually a good-shaped fruit is produced.

Watering must be carefully carried out, as melons resent over-watering and are particularly subject to stem-rot diseases. The plants are kept "rather on the dry side" during the early part of their lives, and during cold, dull weather. When the fruits are developing rapidly, heavier supplies of water are necessary until the fruits begin to ripen, when less water is given. Watering should preferably be done early in the morning, so that no free moisture is present when the temperature falls in the evening. It is necessary to syringe the foliage frequently during favourable weather until the fruits begin to ripen or "net".

Each fruit should be raised off the bed by means of a small piece of wood to keep it dry and clean.

As soon as the danger of late spring frosts is over, full ventilation should be given, and in favourable seasons the lights may be removed entirely.

Marketing. For the wholesale market melons are best cut when the cracks appear on the fruit around the stalk. For immediate sale they may remain on the plants a few days longer, when the colour deepens, a distinct aroma develops, and the fruit becomes soft around the eye.

The melons should be cut with about an inch or two of the fruit-stalk attached, and packed in trays, embedding them in wood-wool in order to prevent bruising. Cucumber boxes without lids fitted with corner pegs (like potato "chitting" trays) are very suitable, since when stacked the bottom of each box is held clear of the fruit in the tray beneath it. The number of melons in a tray varies from 2 to 8 according to the size of the fruit.

Radish. The cultivated radish (*Raphanus sativus*) is probably of oriental origin and is less hardy than the wild radish (*R. raphanistrum*) of Britain and Europe.

The demand for radishes is considerably less now than it was 20 years ago, but where a market for the crop can be found, it often gives high cash returns per acre. Considerable supplies of radishes are imported to this country from Guernsey, France and Germany between October and May.

Radishes form a particularly important crop in Worcester, Middlesex and Bedfordshire, and are grown to some extent in all market-garden districts.

The production of this crop in glasshouses and frames has been discussed elsewhere in this book, and there now follows a brief description of the cultivation of early and main crop radishes out of doors.

Early Crops Out of Doors (usually with some protection). An early type of soil in a sheltered position should be chosen and sunny, sloping banks are advantageous. The soil should be warm, light, well drained, fertile, and rich in humus. Shelter from cold winds is essential and windscreens are often erected. In the Evesham district, where this crop has been produced for many years, beds are made between the plum trees, as these cast but little shade early in the year.

The soil may be dug or ploughed in November, a dressing of organic fertilizer, such as hoof and horn or meat and bone meal, being added at 10 cwt. per acre. Nitro-chalk is an excellent fertilizer, since it supplies both nitrogen and lime, and radishes do not thrive on an acid soil. It should be applied at the rate of 2 to 3 cwt. per acre and raked into the surface. Fish manure may be used instead at the same rate as nitro-chalk. The land should be moderately firm, and a good surface tilth must be made by raking with wooden and iron rakes, removing all large stones and debris.

In January and February seed is sown in the beds either broadcast or in drills 3 in. apart. When broadcast the seed is sown fairly thickly and usually raked in, the soil being afterwards firmed. Alternatively the broadcast seed may be covered by "casting" soil with a spade from the pathways on to the bed. The spade is thrust more or less horizontally into the soil along the "pathway" so as to obtain a layer of soil about 1 in. in depth on the blade. This soil is then cast uniformly over the seed-bed with a low sweeping movement of the spade, which is at the same time turned over. Afterwards the beds should be moderately firmed.

For the earliest sowings the beds are covered with straw or lights immediately after sowing. In Evesham, Bedfordshire, and occasionally elsewhere, it is customary to cover the beds with wheat-straw until germination takes place, when the straw is raked off during favourable weather, and replaced on frosty nights and dry cold days. The labour involved for handling the straw may be considerable, but where Dutch lights are available to cover the beds less labour would be necessary.

The earliest straw-protected sowings may be fit for marketing at the end of February in a favourable season, but the bulk of the crop is ready in March and April.

Early and Main Crops Out of Doors (without protection). These crops also require a fertile soil and are best preceded by a well-manured crop, such as early leeks. The land should be ploughed and subsoiled in early autumn, and, if weather permits, ploughed again before Christmas. About the end of January 10 cwt. of meat and bone meal or 2 cwt. of nitro-chalk per acre should be harrowed in or applied with a manure drill. Radishes grown early in the season should receive rather generous amounts of nitrogenous manures, and varieties should be chosen that give a reasonable amount of top or leaf growth in order to facilitate bunching. Summer radishes tend to produce too much top growth and therefore manuring should be modified accordingly, the seed should be sown less thickly and short-topped varieties chosen.

Except in very mild and sheltered localities sowing should not be made before the last week in February as cold March winds may check the young seedlings. Successive sowings should be made about every ten days. The grower should bear in mind that radishes do not sell well when strawberries and raspberries are plentiful, or after the end of June, and he should therefore reduce his sowings after the middle of May. The usual method of sowing is by means of a special twelve-coulter radish drill, the coulters being 2½ or 3 in. apart. About 1½ to 1¾ bushels of seed per acre are required for the early sowings, but as the season advances the quantity should gradually be reduced to 1 bushel per acre, or even less.

Radish seed varies in size, and when large-seeded varieties such as "Wood's Frame" are sown, the quantity per acre may be increased by ¼ bushel. After sowing, the seed should be covered with about ½ in. of soil and the land rolled with a wooden roller.

Precautions should be taken immediately after sowing to protect the seed from birds, which may otherwise considerably reduce the crop. Where the area to be guarded warrants the expense, the employment of a man with a gun is the best method of protection.

Methods of treating the seed with paraffin or red-lead have often been advocated, but it is doubtful if they are worth while. Birds have been known to remove the husk from treated seeds before feeding on them. Automatic-firing guns and other patent bird scares are also of little value on large areas, as the birds appear to become accustomed to them. On a large scale the employment of a boy with a rattle or a gun, on duty from daylight till dusk, is fairly effective A cheap and effective method can be carried out with the aid of old tins and a good working lad. Flexible poles are thrust firmly at an angle into the ground at each corner of the field, and from each pole several tin cans, biscuit tins, etc., are suspended in a bunch. Long lengths of strong cord are attached to the poles and lead to a central point in the field where the boy stands. By tugging the strings at irregular intervals the birds are effectively scared by the rattling of the tins. On a small scale black cotton is most effective.

Quick growth is essential for the production of good quality radishes, and where overhead irrigation is available it may be used advantageously during drought periods. The crop needs watching, for radishes usually mature altogether, and they must be marketed as soon as ready or they quickly become pithy and unsaleable. In this connexion the grower should remember, when planning the season's cropping programme, that a radish crop takes up an appreciable amount of time to pull, bunch and market. Sowings should therefore be arranged so that the crop is not likely to reach maturity at a time when all available labour is employed on other crops. Pulling and bunching is usually done by women, who are paid on a piece-work basis. At the present time the average piece-work rate is 2*d.* per dozen bunches. The size of a bunch varies, but usually contains 12 to 15 radishes, excepting those for the London markets, where bunches 4½ to 5 in. in diameter are sometimes preferred. The bunches are tied with three-ply fillis. They must never be left exposed to the weather after pulling, but should be taken immediately to the packing shed, where they are washed, rinsed in clean water, and packed in non-returnable crates holding up to 3 dozen bunches.

A good crop should yield about 10 dozen bunches per rod, but up to 15 dozen bunches per rod have been obtained. Frame crops usually yield about 6 dozen bunches per rod.

The following varieties are recommended:

Early Sowings: Wood's Early Frame (long-rooted and chiefly in demand by northern markets), Early French Breakfast, Scarlet Globe, Sparkler and Glowing Ball.

Main Crop Sowings: Scarlet Globe, Glowing Ball, Sparkler, French Breakfast and Short Top Forcing.

White and yellow radishes are not grown commercially, and there is very little demand for the winter-hardy radish Black Spanish.

Spring Salad Onions (*Allium cepa*) are chiefly in demand in March, April and May, for which special sowings are made in August. Sowings are sometimes made from early July. The thinnings from the spring-sown harvesting onions are also sold for salad purposes during June and July.

The seed is sown in mid-August out of doors, the plants standing the winter, and being marketed in the spring. Districts where the winters are very hard are unsuitable for the crop, and the main centres of production are the Evesham districts, Middlesex and Surrey. A good, deep, fairly fertile loam is desirable. Manure is not necessary, but good drainage is essential. Land from which an early potato crop has been taken is very suitable. The land must be well consolidated or poor growth and mildew result. A good surface tilth must be provided, and newly-ploughed land must be rolled and harrowed. Ploughing should be done a month before sowing, and if the land is harrowed two or three times many weeds are destroyed. Seed of the variety White Lisbon is sown thickly, 56 lb. per acre in drills 10 in. apart. The exact time of sowing depends on the locality; in the north of England sowing is done in early August, but in the south the middle or the end of August is more suitable.

It is usually worth while to apply before sowing a mixture of 3 cwt. superphosphate and 2 cwt. sulphate of potash per acre. This encourages root action and sturdy growth, assisting the plants to withstand the winter. In the spring the young plants need nitrogen to hasten growth, and a top dressing of soot, 5 cwt. per acre, is often applied in January. Early in February a top dressing of 1 cwt. nitrate of soda per acre is beneficial. On some soils hoof and horn meal may be preferable as a top dressing if applied earlier in the season. Cultivation consists of frequent hand-weeding and hoeing in the autumn and in the spring.

The young onions are bunched on the field (on temporary tables), a fork being used to loosen the soil to assist in pulling the crop. Most markets prefer the bulbs undeveloped, but a few prefer them more mature. The size of the bunches varies in different localities, e.g. in Middlesex, Essex and Kent a bunch weighs 3 to 5 lb., but in some parts of the north of England only 12 to 14 onions are tied in a bunch. The onions are tied with osiers or willow shoots or raffia. The bunches are placed in tanks of water to soak a while and then washed clean, being handled with reasonable care. The surplus water is drained off and the bunches are then packed in returnable bushel boxes or wicker baskets of about the same capacity. Non-returnable wooden crates, similar to those used for lettuce, are used by some growers and have the advantage of being well ventilated.

Watercress (*Nasturtium officinale*). This is a very popular salad crop, rich in vitamins and possessing medicinal properties due to its mineral and oil content. It is marketed practically all the year round, but it is in greatest demand during April and May. Although grown to some extent in most counties in this country, the main sources of supply for markets are Berkshire, Buckinghamshire, Cheshire, Dorset, Gloucestershire, Hampshire, Hertfordshire, Kent, Lancashire, Norfolk, Shropshire, Surrey, Sussex, Wiltshire and Yorkshire.

Water Supply. Market growers of watercress produce the crop in specially-constructed beds fed with water from springs, streams or artesian wells. Whatever the source, the water must be pure and kept free from contamination. Stream water fluctuates in temperature according to the air temperature, hence well or spring water that comes from the ground usually at an average of 50° to 52° F. all the year round is preferred, as steady growth is obtained even during winter-time. If the source is some distance from the beds the water must be adequately covered to retain its warmth.

Districts having water-bearing formations, such as chalk and greensand, are particularly suitable for watercress cultivation, and many successful beds are also found on the New Red Sandstone areas.

Watercress will not grow in all waters, and the presence of any chemical impurities may inhibit growth.

It should always be remembered that the water must be disposed of easily after use in the beds, so that proximity to a watercourse is essential.

Construction of the Beds. Watercress grows naturally at the sides of some streams, but the commercial grower constructs beds that involve considerable capital outlay. Cheaper beds may be made, but they are more expensive in upkeep and repairs, and usually afford greater facilities for pests and water contamination.

A well-constructed watercress bed should have walls and footways of concrete, strongly made with surfaces rendered smooth. A width of 25 to 30 ft. is convenient, and the length should not exceed the width. For winter production the beds should be shorter and narrower in order to assist in maintaining the water temperature. The surrounding walls, which also form the footways, should be 2 ft. in height and 18 in. wide. A reservoir, 4 to 5 ft. wide and 2 ft. deep, is constructed at the head of the bed and separated from it by a 2-ft. wall. Water is fed into the reservoir direct from the source of supply, and a feed pipe supplies water to the bed under the control of the grower. An overflow pipe is provided.

The surface of the bed should be approximately 1 ft. from the top of the walls and made with a gradual fall to the bottom end of the bed, where an outlet pipe is fitted so that the bed may be emptied when necessary.

In large-scale production the watercress is transported on trucks running on light railways from the cress beds to the packing sheds, which are conveniently placed in the centre of the block of beds. A good road is made from the packing shed to the main roads for the convenience of marketing.

Propagation. The commercial grower has carefully selected many improved strains of watercress and propagation is by means of cuttings. Propagation by seed is possible but not popular. The two main types grown commercially are the Brown Winter watercress grown for winter and early spring cutting; and the Green Summer watercress—for summer and autumn use. Brown Winter cress is grown extensively in water rising, at a temperature of about 50° F., direct from chalk formations. The summer cress has larger leaves but the public apparently prefer the brown type during the winter. Care in the choice of a variety and strain suitable for the locality and market demand is important.

Time and Propagation. Summer cress should be planted in the spring as soon as the danger of frosts has passed. Brown Winter cress should be planted during July, August and September. Later plantings are unreliable. At the end of the cropping season, stock beds of selected material are usually made up to provide cuttings for the new beds. It is advisable to clean out and replant the beds every two years and preferably after each cropping season. If this is not done the beds must be "dressed" by flooding with water and moving the plants with rakes to facilitate cleaning.

Frost. When severe frost is expected the watercress should be given some protection from damage by submerging it beneath the surface of the water. Light rollers made of wooden slats, or long-handled flat reed brooms, may be used for the purpose. After treatment the watercress will normally remain under water overnight.

Cleaning and Replanting Beds. All roots, stems, etc., of the previous crop must be removed, the beds "dressed" and water admitted freely to carry away all debris and weeds. The beds are then drained and the surface made level and firmed with the back of a rake. Sufficient water is admitted to cover just the surface, and after the material has settled down, the beds are ready for planting. Cuttings, consisting of well-matured top growths, 6 to 9 in. long, and taken from selected stock, are scattered thinly over the surface of the beds. The cuttings root at the joints in a few days and more water is added gradually so as not to flood off the plants before they are well rooted. Spring watercress takes about four months from the time of planting to reach the market stage.

Cutting and Marketing. Cutting is done with a sharp knife, and the cress placed in a container, which, when full, is conveyed to the packing shed. Here it may be packed loose, or bunched. The standard package, nowadays, is the non-returnable "12-lb. chip" which holds about 7 lb. of watercress, or 36 bunches. When packed loose the cress is carefully placed with the shoots level and the stems pointing outwards.

Wicker half-flats or quarter-flats are still used by some growers for bunched and unbunched watercress. A half-flat contains about 17 to 25 "hands" of unbunched cress, each weighing 1¼ lb. or more, or about 8 or 9 dozen bunches. For bunching the cress is placed in a packing shed on benches with the stalks towards the buncher. A practised buncher can pick up sufficient cress for a bunch at one grasp of the hand, and secures it with thin raffia, a rubber band, or paper wrapper. The stems are cut level to form a bunch usually of about 6 in. in length. The number of shoots in a bunch varies according to quality and season, but the size aimed at is such that 3 dozen bunches will fill a chip when well packed. When the chip is filled, another worker places on it a lid of thin wood veneer and ties it down securely with string. The chips are then placed in a clean cooling tank containing pure spring water. Before despatching, the chips are removed from the tank, drained and labelled with their destination, grade and sender.

Watercress must be placed on the market in a perfectly fresh condition and when possible it is cut early in the morning and marketed the same day. Usually, however, cutting is done in the morning ready for bunching and packing in the afternoon, when it is despatched so as to be on sale in the markets on the following morning.

Pests. Hygienic methods of production lessen the attacks of pests such as the Mustard Beetle (*Phædon cochleariæ*), Caddis Fly (Order—*Trichoptera*), and Fresh Water Shrimp (*Gammarus*). The Mustard Beetle is usually the most injurious and may be controlled by flooding the beds or by application of Derris or Pyrethrum dusts. There appear to be no serious diseases of watercress.

Chapter Twelve

Diseases and Pests

Even the best growers sometimes have difficulty in controlling plant pests and diseases; but few will disagree that good cultivation, in the widest application of the term, can contribute substantially towards the prevention of these troubles. Prevention is better than cure, and under the term "good cultivation" one may include effective land drainage, deep and thorough tillage, correct manurial treatment and rotation of crops, eradication of weeds, disposal of rubbish, and general cleanliness in the garden or farm. Seed should not be sown too thickly, and when thinning out or transplanting is necessary the work should be done in good time and with care and skill. When transplanting, all diseased plants should be rejected and burnt. Sometimes the spread of disease may be checked by the removal and destruction of affected plants from the seedling or cropping beds. The selection of disease-free seed and the choice of resistant varieties when available is important. Under glass, additional factors include efficient ventilation and watering, and the maintenance of suitable atmospheric and soil temperatures.

Good cultivation implies skilful management of the soil to build up and maintain its fertility, paying particular attention to soil texture. This does not mean that plants grown in such soils are almost immune from pests and diseases, though it is probably true to say that plants grown in such soils are less subject to disease infection. On the other hand, a well-grown crop may occasionally prove more attractive to plant pests than one poorly grown and half starved, and though its vigorous constitution may enable it to survive the attack, the presence of the pest and the damage caused may render the crop unmarketable. Nevertheless, the source of infection should be sought, and it may be that this will be traced to weeds, neglected ditches, or perhaps the preceding crop. Intelligent observation is the grower's best weapon against pests and diseases, for thus he is enabled to take control measures while the trouble is slight, and by prompt action save the crop at the minimum of expense. When crops are to be grown in glass-houses, frames or boxes, it is possible to prevent initial attacks of soil-born diseases and pests by sterilization of the soil.

Soil Sterilization. The objects of soil sterilization are to destroy pests and diseases in the soil and to increase its general fertility. Correctly speaking, the term should be partial-sterilization, as completely sterilized soil is useless for plant growth. On most nurseries it is desirable to sterilize the propagating soil to prevent "damping off" diseases and to kill weed seeds.

Hygiene. Whatever the method of sterilization employed, it is important to take ordinary care to prevent re-infection or contamination of the soil after treatment.

Thus, all boxes, pots, tools, etc., used in connexion with the treated soil must be sterilized, and care taken to prevent re-infection from the floor on which the soil is placed or from infected soil carried by hose-pipes, the boots of workers, and by other agencies. Surface drainage water is another possible source of infection. All frames and lights should be cleaned and disinfected each year before the commencement of each season by scrubbing them well with a 2 per cent solution of cresylic acid (with enough soft soap to make a lather) or other efficient sterilizer. It is wise to wear rubber gloves for the work. Glass-houses are usually cleansed by spraying them thoroughly inside and outside with one of the solutions mentioned. A house 200 ft. by 28 ft. requires approximately 50 gal. of solution inside and 25 gal. outside. The workmen should wear goggles.

Partial Sterilization by Heat. This is recognized as the most effective method of soil sterilization. Heating may be effected by steaming, baking or electricity.

The soil should be raised to a temperature of 210° to 212° F. and maintained at that temperature from 30 to 60 mins. according to texture. A heavy soil requires a longer period than a light soil. If the temperature is raised too high, the soil is rendered useless for plant growth.

After sterilization the soil should be left for five weeks before use, but turned with sterilized tools several times during this period.

Baking alters the physical condition of the soil more than steaming. It is advisable to moisten the soil before baking and to add peat afterwards to improve the texture and water-holding capacity. Various types of apparatus for steaming and baking are on the market and sometimes home-made apparatus is satisfactory.

Partial Sterilization by Chemicals. Formalin (40 per cent formaldehyde) is the substance in most general use, but many reliable proprietary products are available. Cresylic acid is also used but both this substance and formalin appear to act mainly as soil improvers and cannot be depended upon to destroy all soil pests.

Formalin is applied as a 2 per cent solution and is prepared by adding one gallon of formalin (40 per cent formaldehyde) to 49 gal. of water.

For Frame Beds. Sterilization of the soil in the frames before seed-sowing or planting-up has been found worth while, particularly against lettuce and celery diseases. The beds are watered with a 2 per cent solution of formalin at the rate of 2 gal. of solution per sq. yd. The soil should be covered afterwards with sacking previously soaked in formalin, then the lights put on and kept closed for two or three days. Subsequently all trace of the fumes must be dispersed from the soil by ventilating the frames, removing the lights entirely during fine weather, and stirring the soil with sterilized tools each day for a fortnight.

For Prepared Composts. For sterilizing one ton of propagating soil or frame-bed compost (approx. 1 cub. yd.) about 75 gal. of the dilute solution is required. The work should be done in a covered shed and the floor damped with the solution beforehand. The soil should be treated in layers not more than 6 in. deep, and when completed the heap should be covered with sacks or a tarpaulin, previously sprayed with solution. The covering should be removed after 48 hours and the soil turned several times at intervals of a few days, sterilized tools being used. The soil should cease to smell of formalin in four or five weeks, when it is ready for use.

For Glasshouse Soils. Formalin at the same strength as above is usually applied at the rate of 4 gal. per 10 or 12 sq. yd. The whole of the floor space should be treated, including the pathways, around the pipes and other fixtures. The soil should be treated and subsequently forked over some weeks before planting begins.

For Growing Seedlings. Where sterilized soil is not used for propagating, boxes of seedlings may be watered with certain chemical solutions to reduce losses from "damping-off" diseases. A dilute solution of permanganate of potash is used by some growers, and a little is sometimes added to the water tank.

Cheshunt Compound is probably the most reliable preparation for boxes for seedlings. It consists of 2 parts by weight of copper sulphate and 11 parts by weight of *fresh* ammonium carbonate. These substances must be crushed to a fine powder and then thoroughly mixed and stored for 24 hours in a tightly-corked glass jar before use. The mixture should not be stored in ordinary metal vessels as it corrodes them and loses strength. Only as much as is required for immediate use should be prepared. Half an ounce of the mixture should be dissolved in each gallon of water and the seedlings watered with the solution. Seed-boxes are often watered with the solution a few hours before sowing, as a preventive.

DISEASES*

BEANS (DWARF, KIDNEY)

Anthracnose (*Colletotrichum Lindemuthianum* (Sacc. & Magn., Bri. & Cav.)) (F.). This disease is not very common in this country, appearing only in cold weather.

Dark brown sunken spots are found on the leaves, stems and pods. The most serious damage is done to the pods, rendering them unsaleable, while the seeds may also be affected.

(1) Only seeds from healthy plants should be sown, and plants showing any signs of infection should be removed.

(2) Spraying with half-strength Bordeaux mixture has been recommended, applying before the pods are set, and afterwards a solution of 1 oz. liver of sulphur and 4 gal. of water may be used until the pods are half grown.

REFERENCES

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.
ALCOCK, N. L.: *Gard. Chron.*, 1928, **84**, 293.
HEALD, F. D.: *Manual of Plant Diseases*, 1933.

"Halo Blight" (*Bacterium medicaginis phaseolicola.* Burkh. Link. & Hall (Sack.) E. F. Sm. var.) (B.). Losses due to this disease have only been noticed in recent years in this country. The plants wilt suddenly owing to the blocking of the water-conducting cells by the bacteria. Small spots surrounded by a light-coloured halo appear on the leaves, while the stems and pods may also be attacked.

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* N.B.—The nature of the disease is indicated by a letter after each name, viz.: B = Bacterial; F = Fungoid; V = Virus.

(1) As the disease is seed-borne, care should be taken to use only clean seed.

(2) Affected plants should be removed as soon as observed.

(3) The following varieties have been found to be fairly resistant to the disease: Black Wonder, Ne Plus Ultra, Superlative, Abundant, Unrivalled and Black Prince.

REFERENCES

OGILVIE, L., and MULLIGAN, B. O.: *Report of the Agricultural and Horticultural Research Station, Bristol*, 1932.

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

Foot Rot (*Fusarium martii*) (F. Solani (*mart.*), var. *martii*) (F.). In affected plants lesions are formed on the stems and roots, and the plants are yellow and stunted.

(1) Long rotation should be tried if possible.

(2) Work is being carried out with the object of discovering resistant varieties, but no results have as yet been published.

REFERENCES

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

OGILVIE, L., and HICKMAN, C. J.: *Report of the Agricultural and Horticultural Research Station, Bristol*, 1936.

Mosaic (V.). The leaves have a mottled appearance and may be confused with the symptoms shown by Halo Blight. The pods may become distorted, and the seeds infected.

Only healthy seeds should be used. So far little work has been done to try and control the disease, but there is a possibility that resistant varieties will be found.

REFERENCE

OGILVIE, L., and HICKMAN, C. J.: *Report of the Agricultural and Horticultural Research Station, Bristol*, 1936.

CARROTS

Young carrots grown under intensive systems do not suffer from any diseases serious enough to deserve mention. (Sclerotinia Rot, Violet Root Rot and Soft Rot are diseases of "stored" carrots.)

CAULIFLOWERS

Finger-and-Toe or Club Root (*Plasmodiophora brassicæ* Wor.) (F.). This disease is very well known and needs little description.

Large galls are formed on the roots of the plants, and the whole root system may be affected. On being cut through the galls are found to consist of solid tissue, thus differing from the galls caused by the Turnip Gall Weevil, which are hollow and, for some time after they appear, contain a grub. The disease is soil-borne and is very prevalent in acid soils and where the drainage is bad.

(1) Under intensive cultivation in frames only sterilized soil should be used, though the disease is rarely serious under these conditions.

(2) As the fungus can live on the soil up to seven years a satisfactory rotation is difficult to carry out, especially since other crops and weeds of the same family (Cruciferæ) are susceptible.

(3) Heavy dressings of lime are required if they are to be effective—up to 4 tons per acre being often necessary. Gas-lime is most effective, but difficult to obtain.

(4) The use of mercuric chloride (corrosive sublimate) has been adopted for the watering of the seed-beds before sowing, again when the seedlings have germinated, and finally when the plants are put out in their permanent positions. The strength of the solution should be 1 oz. of mercuric chloride in 12 gal. of water, but it must be realized that this treatment is only preventive, and must be repeated at each sowing. This substance is highly poisonous to man and animals.

(5) Application of calcium cyanamide three weeks before sowing or planting (at the rate of 5 lb. per sq. rod).

(6) Stimulants such as nitro-chalk, or sulphate of ammonia in spring to encourage growth.

REFERENCES

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.
SHEWELL-COOPER, W. E.: *Gard. Chron.*, 1932, **91**, 387–8.
—— *Gard. Chron.*, 1933, **92**, 83.
PRESTON, N. C.: *Jour. Min. Agric.*, 1931, **38**, 272–84.
MURRAY, J.: *Gard. Chron.*, 1935, **97**.

Ring Spot (*Mycosphærella brassicicola* (Fr.) Lindau) (F.). This disease is quite common but rarely does serious damage and occurs chiefly in broccoli.

The symptoms are shown as more or less round brownish spots on the leaves, which, when badly attacked, die off.

Apart from the removal of decayed material, which checks the disease, little else can be done. Some varieties have proved more resistant than others in Devon and Cornwall.

Reference

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

Downy Mildew (*Peronospora parasitica* Pers., Tul.) (F.). This may do considerable damage in certain seasons, especially to the seedlings and crops grown in frames.

The undersides of the leaves becomes covered with white downy patches, and the plants look very unhealthy.

(1) Much can be done by providing good growing conditions, e.g. thin sowing, thinning seedlings, adequate soil preparation and attention to ventilation.

(2) Spraying with potassium sulphide (liver of sulphur), 1 oz. to 2 gal. of water, has been tried as a control, but it is doubtful whether it is a paying proposition.

(3) The soil should not be allowed to become excessively dry, and ample space should be given to the plants in frames.

Reference

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

White Blister (*Cystopus candidus* Pers., de Bary) (F.). This rarely does serious damage, and when it does occur it is generally found in conjunction with Downy Mildew. Cruciferous weeds such as Shepherd's Purse (*Capsella bursa-pastoris*) are also susceptible.

As to control, see Downy Mildew.

Black Rot (*Pseudomonas campestris* Pam., E. F. Sm.) (B.). Not common in this country. The symptoms are very characteristic, occurring as a yellowing of the leaves and a blackening of the vein. If the stalks of diseased plants are cut across a characteristic black ring may be observed.

Control consists of:

(1) Removal of diseased refuse.
(2) In frames only sterilized soil should be used.
(3) Rotation is advisable where the trouble is serious.

References

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.
Heald, F. D.: *Manual of Plant Diseases*, 1933.

Soft Rot (*Bacillus carotovorus* L. R. Jones) (B.). This usually does not appear until the plants are fully grown, when the inside of the curd may become a rotten, evil-smelling mass, although the outside may merely show discoloured patches at first.

It is probably true that overhead watering in hot weather encourages the disease.

CELERY

Root Rot (*Phoma apiicola* Klebahn) (F.). This disease was first identified in 1924, and was found to be fairly common. Diseased plants develop dark brown or black patches on the roots and stems just below ground level, and in bad attacks the tops may die off.

The disease is seed-borne, and affected seed should be treated with a solution of 1 part of formalin to 300 parts of water, for three hours. This, however, does not give a complete control.

REFERENCES

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

STIRRUP, H. H., and EWAN, J. W.: *Investigations of Celery Diseases and their Control,* Bulletin No. 25, Ministry of Agriculture and Fisheries.

Damping Off and Root Rots (*Pythium* spp. etc.) (F.). These are common diseases in the seed-bed. Patches of seedlings are poor in growth or withered and come away easily in the hand, or have collapsed on to the surface of the soil.

Sterilization of the soil by heat or chemicals is advisable before sowing. A 2 per cent solution of formalin should be watered on to the prepared seed-bed at the rate of from 2 to 4 pints per square foot. The frames are kept closed for two or three days. The soil should afterwards be freed from formalin by stirring with a rake (previously dipped in formalin) daily for ten to fourteen days. Meanwhile the lights are removed on all fine days.

Watering the seed-beds with Cheshunt Compound should prevent the disease spreading.

REFERENCE

STIRRUP, H. H., and EWAN, J. W.: *Investigations of Celery Diseases and their Control,* Bulletin No. 25, Ministry of Agriculture and Fisheries.

Celery Spot (*Septoria apii*) (F.). This is the most important disease of celery. The presence of the disease in the seedling stage may not be obvious, but if affected seedlings are examined closely small spots will be found on the young leaves. Later the disease becomes very apparent as groups of minute black spots, which spread very rapidly. The best means of control are as follows:

(1) As the disease is seed-borne, only healthy seed should be used. Seed that is not clean should be treated with a solution of 1 part of formalin with 300 parts of water for three hours, which will appreciably reduce infection, but is not a complete control. The seed is suspended in a muslin bag and agitated to remove air.

(2) Spraying the plants with Bordeaux mixture (4 lb. copper sulphate, 6 lb. hydrated lime and 40 gal. of water) as soon as the disease is seen will check the disease, and should be done at regular intervals of two or three weeks.

(3) Removal of all diseased plants and maintenance of general hygienic conditions.

(4) Production of disease-free seed by keeping seed-plants free from disease throughout their lives, by spraying with Bordeaux mixture (see ref.*)

REFERENCES

ANON.: Advisory Leaflet No. 241, Ministry of Agriculture and Fisheries.
* STIRRUP, H. H., and EWAN, J. W.: Bulletin No. 25, Ministry of Agriculture and Fisheries.
Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.
SMITH, E. HOLMES: *Gard. Chron.*, **93**, 193–4.

Soft Rot (*Bacillus carotovorus*) (B.). This disease may cause considerable losses. The hearts of badly affected plants develop a soft brown rot, and render them useless for market. The disease usually gains entrance by means of wounds, caused by slugs, snails, or the larvæ of the carrot fly. For control one should practise:

(1) Removal of affected plants.

(2) Everything possible to keep down the slugs, snails and carrot fly.

REFERENCES

OGILVIE, L., MULLIGAN, B. O., and BRIAN, P. W.: *Report of the Agricultural and Horticultural Research Station, Bristol*, 1934.
Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

CRESS—(Mustard and Cress)

Damping Off (*Pythium de baryanum*) (F.). This fungus often attacks the young seedlings when sown too thickly, and under wet conditions. Only sterilized soil should be used; and the soil should be watered with Cheshunt Compound.

LETTUCE

Mosaic (V.). This disease seems to be spreading every year. The symptoms vary considerably according to the variety. Some of the more common symptoms are a mottling and crinkling of the leaves, and a stunting of the plants, which develop very poor hearts.

This disease is seed-borne to some extent, so only seed obtained from healthy plants should be used.

All the aphides that are found on lettuce are responsible for spreading this virus and should therefore be kept under control.

For further particulars in regard to this disease, see references below.

REFERENCES

OGILVIE, L., MULLIGAN, B. O., and BRIAN, P. W.: *Report of the Agricultural and Horticultural Research Station, Bristol,* 1934.

OGILVIE, L., and BRIAN, P. W.: *Report of the Agricultural and Horticultural Research Station, Bristol,* 1935.

AINSWORTH, G. C.: *Report of the Experimental and Research Station, Cheshunt,* 1936.

Downy Mildew (*Bremia lactucæ* Regel) (F.). This disease is very common throughout the country on lettuces grown under glass. The leaves become yellowish in colour, later turning brownish and shrivelled, and the plants are stunted. On the backs of the leaves a white dusty mildew will be found.

(1) Under glass, excessive humidity should be avoided, and after watering the temperature should be raised for 24 to 48 hours, if possible, to counteract the effect of "chilling" the soil.

(2) The possibility of selecting resistant varieties is important. Trials have been carried out and it is claimed that under commercial conditions in Lancashire the varieties Loos Tennis Ball and Rosy Spring are highly resistant. In some trials at the Royal Horticultural Society's Gardens at Wisley, cos lettuce was shown to be very susceptible.

Jagger, at Cheshunt Research Station, found that a French variety of cabbage lettuce, named Laitre du Saint Ilan, proved highly resistant.

(3) A dry soil or any check to the growth of the plants appears to favour the incidence of the disease.

(4) The careful removal and burning of affected leaves, as soon as observed, is probably the best method of preventing the spread of the disease in glasshouses and frames.

(5) Various fungicidal dusts have been tried but cannot be whole-heartedly recommended.

REFERENCES

MACPHERSON, N. J.: *Jour. Min. Agric.*, 1932, **38**, 998–1003.
Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.
JAGGER, I. C.: "Lettuce Mildew", *12th Annual Report of the Experimental and Research Station, Cheshunt*, 1926–27.

Botrytis, Grey Mould, Red Leg, Canker or Collar Rot (*Botrytis cinerea* Pers.) (F.). This fungus, variously named as above, is one of the most serious diseases of lettuces, particularly of seedlings and young plants grown under glass, and the less hardy of those grown out of doors during winter.

Both seedlings and fully-grown plants may be attacked. In seedlings, the cotyledons are usually infected first, but later infection spreads to the stems at about ground level. On the stems of seedlings and more mature plants the fungus causes a kind of reddish-brown canker, which results in rotting of the plant tissue, so that eventually the plant wilts and dies. Affected plants may linger on for many weeks, but make very poor growth.

On the diseased surfaces of stems and leaves the spores of the fungus appear, under suitable conditions, as a grey fluffy mould. Control measures include:

(1) Removal and burning of all diseased material. The Cheshunt Research Station has recommended a daily inspection of lettuce plants grown in glasshouses, and the removal of each infected leaf as soon as observed. Hygienic conditions must be maintained throughout. In frames, debris such as pieces of straw litter on the surface is said to spread the disease.

(2) Excessive humidity in glasshouses and frames encourages the spread of the disease.

(3) Dusting with various proprietary articles of organic mercurial origin (e.g. Folosan) has proved effective in many instances, but some "hardening" of the growth of the plant usually ensues, particularly under glasshouse and frame conditions.

(4) For frames and glasshouses, steam or chemical (formalin) soil sterilization has proved helpful.

(5) Seed-beds, especially in frames, should be prepared early and thoroughly, so that the surface tilth is fine and free from lumps and the soil of the right degree of moisture, and not too cold.

(6) Seedlings should be handled and transplanted with care, damage to the stems and leaves being avoided.

(7) At Long Ashton Research Station the following varieties of hardy outdoor lettuce were found to be somewhat resistant: Arctic King, Imperial, Yate's Winter White, Lee's Immense, and McHattie's Giant (see ref.*).

(8) The foliage of seedlings—overwintering in frames or glasshouses—should not be allowed to become wet.

References

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

Ogilvie, L., and Mulligan, B. O.: *Report of the Agricultural and Horticultural Research Station, Bristol*, 1934, pp. 182–6.

*—— —— *Sci. Hort.*, 1935, **3**, 122.

Brown, W.: *Journal of Pomology*, **13**, 247–59.

White, H. L.: *Report of the Experimental and Research Station, Cheshunt*, 1933.

Leaf Spot (*Pleospora herbarium* Pers., Rebenk.) (F.). This disease has appeared in the western districts of England. The symptoms are light brown circular spots on the leaves, which may later coalesce and the whole patch become dry and shrivelled.

The disease has not been serious enough as yet to necessitate control measures.

Reference

Ogilvie, L., and Mulligan, B. O.: *Gard. Chron.*, **89**, 35 (also in *Report of the Agricultural and Horticultural Research Station, Bristol*, 1930, pp. 133–1934).

Bacterial Spot (*Bacterium marginale*) (B.). This disease is not often very serious. The symptoms appear first as a browning on the leaf edges, extending inwards to attack the veins, which also become brown. Secondary organisms usually follow and reduce the plants to a wet rotting mass.

(1) Under glass a dry atmosphere should be maintained.

(2) Very heavy manuring should be avoided as this increases the possibility of attack.

REFERENCE

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

Ring Spot (*Marssonina panattoniana* Berl., Magn.) (F.). This disease is now prevalent throughout the country, and is most serious in cold wet weather and during the winter months. It first appears as brown spots on the leaves, which later become covered with spores. The central parts of the spots then fall away, leaving holes with white edges. The underside of the mid-rib may be attacked, causing sunken brown patches to appear. The outside leaves are the first to be infected, the disease spreading inwards to cause the death of the plant.

The following control measures should be mentioned:

(1) Removal of all diseased material, and when possible the practice of a rotation. The disease is often observed to be spreading from isolated centres consisting of single infected plants.

(2) Under glass, buoyant conditions tend to keep down the disease.

(3) A change of varieties has sometimes proved effective.

(4) The varieties of cabbage lettuce Arctic King and McHattie's Giant appear to be somewhat resistant.

REFERENCES

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.
OGILVIE, L., and MULLIGAN, B. O.: *Report of the Agricultural and Horticultural Research Station, Bristol*, 1933, pp. 110–12.

MELON

Stem Canker (*Bacillus carotovorus*) (B.). This disease does not usually attack the plants until the fruit is nearly ripe, then causing a wilting and finally a total collapse of the plant.

The trouble is caused by water getting near the base of the stem, and this should be avoided. It appears at the soil level and is typically a rotting of the outer tissues.

(1) To keep the base of the stems dry, the plants should be

put out in metal collars (5 in. diameter) or pots with the bottoms knocked out. No water should be allowed to get inside the collar or pot.

(2) Dusting with a mixture of 10 parts of slaked lime, 2 parts of ground copper sulphate, and 2 parts of flowers of sulphur. This should be sprinkled around the plants before the damage is serious.

REFERENCE

BEWLEY, W. F.: *Diseases of Glasshouse Plants*, pp. 124–6.

Blotch (*Cercospora melonis*) (F.). The first signs of the disease appear on the leaves as water-soaked spots which later turn brown. As the disease is only serious under conditions of high temperature and humidity this should be avoided. Spraying has not been found economical.

REFERENCE

On Cucumbers: See BEWLEY, W. F.: *Diseases of Glasshouse Plants*, p. 72.

Mildew (*Erysiphe cichoracearum*) (F.). This is quite a common disease but is rarely serious.

The symptoms appear as powdery growths on the leaves and sometimes the stems. Later the whole plant may take on a whitish appearance. Control measures include:

(1) Removal of badly-affected plants.

(2) Dusting with finely-divided sulphur, or spraying with liver of sulphur, 1 oz. to 3 gal. of water.

(3) Recent tests with salicylanilide (e.g. Shirlan A. G.) in the form of paste, with a suitable spreader, have given promising results.

REFERENCE

ORCHARD, O. B.: "Control of Cucumber Mildew", *Report of the Experimental and Research Station, Cheshunt*, 1932.

Verticillium Wilt (*Verticillium albo-atrum*) (F.). This is a well-known disease of tomatoes and occasionally attacks the melon.

The symptoms are shown as a wilting of the plant and a yellowing of the leaves, followed by a total collapse of the plant. When the stem is cut across it will be seen to have a yellow or brownish colour.

(1) As it is a low temperature disease, attempts should be made to prevent sudden drops in temperature. If it does appear,

the temperature should be raised to 77° F., which will check the spread of disease.

(2) Shading of the houses by means of whitening on the glass helps the plants to resist the disease.

(3) In making up the beds only sterilized soil should be used.

(4) Diseased plants should be removed with the surrounding soil.

REFERENCE

BEWLEY, W. F.: *Diseases of Glasshouse Plants.*

Fusarium Wilt (*Fusarium vasinfectum* var. *niveum*) (F.). Fusarium Wilt is not uncommon is this country as the high temperature that is favourable to the melon is also suitable for the spread of the disease. The symptoms are similar to those shown by Verticillium Wilt. On cutting the stem across, however, the colour of the cut portion is generally seen to be reddish brown.

(1) Only sterilized soil should be used.

(2) Removal of diseased plants and the surrounding soil is desirable.

(3) As a preventive, watering with Cheshunt Compound, 1 oz. to 2 gal. of water, should be practised.

REFERENCE

BEWLEY, W. F.: *Diseases of Glasshouse Plants.*

MUSTARD

White Blister (*Cystopus candidus*) (F.). The first signs of this disease appear in the form of shiny pustules on the leaves. The disease, however, is rarely serious on mustard grown for salad purposes. All infected seedlings should be burnt.

ONION

Onion Smut (*Urocystus cepulæ*) (F.). This is a scheduled disease under the Destructive Insect and Pests Acts, 1877–1927, and must be reported immediately to the Ministry of Agriculture or local police.

Onions can only be attacked in the seedling stage. It appears as spots or streaks on the leaves, these marks later splitting to liberate powdery masses of spores.

The disease is carried over in the soil, so this presents a great difficulty.

(1) Watering the drills with formalin (1 gal. to 300 gal. of water) immediately after the seed has been sown, before covering in, has given good results.

(2) All diseased material should be removed and burnt.

REFERENCES

ANON.: Advisory Leaflet No. 365, Ministry of Agriculture and Fisheries.
Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.
WHITEHEAD, T.: *Jour. Min. Agric.*, 1921–2, **28**, 443–50.

Downy Mildew (*Peronospora schleideniana*) (F.). This is more troublesome in wet seasons, varying to some extent according to the district. The symptoms first appear on the leaves, which become pale, and later wilt and decay. The spores of the fungus can be seen on the dying leaves, and serve to spread the disease. The mycelium may penetrate into the bulb itself.

(1) Damp situations should be avoided.

(2) Spring-sown onions should be kept as far away as possible from the autumn-sown crop, and from shallots.

(3) The varieties Cranston's Excelsior, Rousham Park Hero, and Up-to-Date are more resistant than All the Year Round, Stirling Exhibition and Wethersfield Red.

(4) Spraying with Bordeaux mixture has been tried but has not been very successful.

REFERENCES

ANON.: Advisory Leaflet No. 85, Ministry of Agriculture and Fisheries.
—— *Vegetable Diseases*, Bulletin No. 68, Ministry of Agriculture and Fisheries.

White Rot Disease (*Sclerotium cepivorum*) (F.) is quite common and may cause considerable losses. The symptoms appear about the end of May, usually on the autumn-sown onions. The older leaves turn yellow and die off, while the other leaves collapse later.

Diseased plants can easily be pulled out of the soil, as their roots have decayed. At the base of the bulb a white fluffy growth will be found, which is the mycelium of the fungus. Eventually the whole bulb becomes a rotten mass.

(1) Affected plants should be removed, care being taken not to contaminate other soil.

(2) The varieties Up-to-Date, Rousham Park Hero, Improved

Reading and White Spanish are a few of the more resistant varieties.

(3) Rotation of crops should be practised as much as possible.

REFERENCES

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.
ANON.: Advisory Leaflet No. 62, Ministry of Agriculture and Fisheries.
COTTON, A. D., and OWEN, M. N.: *Jour. Min. Agric.*, 1920–21, **26**, 1093–9.

RADISH

Club Root (*Plasmodiophora brassicæ*). F.
Downy Mildew (*Peronospora parasitica*). F.
White Blister (*Cystopus candidus*). F.

These diseases are rarely serious on radishes. Symptoms and control measures can be found under cauliflower diseases.

TURNIP

Club Root (*Plasmodiophora brassicæ* Wor.) (F.) disease is first found on the roots as small nodules, which later increase in size, and the roots become very misshapen.

(1) When turnips are grown in frames sterilized soil only should be used.

(2) For other control measures, see cauliflower diseases.

Black Rot (*Pseudomonas campestris*) (B.) disease sometimes attacks turnips. The internal tissues of the root become a dark brown colour, while from the outside the root seems quite healthy. Control measures include:

(1) Destruction of all diseased material.

(2) In frames the use of only sterilized soil.

(3) A system of rotation if possible, although this is difficult as the disease also attacks other members of the cabbage family.

REFERENCE

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

Soft Rot (*Bacillus carotovorus*) (B.), which starts at the crown or gains entrance through wounds, producing a soft rot. Control measures include:

(1) Removal of diseased material.

(2) In frames the use of only sterilized soil.

REFERENCE

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

Dry Rot (*Phoma lingam*) (F.) is not often found under intensive cultivation. Small, pale yellowish spots, oval in shape, with the long axis horizontal, appear on the root. Large cracks develop, and the roots may become rotten.

(1) The disease may be seed-borne, but the percentage of infected seed is not very high.

(2) Removal of all diseased material.

(3) Cruciferous weeds are also subject to attack, and so spread the disease. These should be kept down.

REFERENCE

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

Downy Mildew (*Peronospora parasitica*). F.
White Blister (*Cystopus candidus*). F.

These diseases may attack seedlings and plants grown in frames. For symptoms and control see cauliflower diseases.

Powdery Mildew (*Erysiphe polygoni*) (F.) is quite common on turnips, late in the season, especially in dry summers. A whitish growth appears on the leaves, and, in exceptional cases, the foliage may be destroyed, causing a reduction in yield.

Apart from the removal of diseased material, no control measures have been considered necessary.

VEGETABLE MARROW

Powdery Mildew (*Erysiphe cichoracearum*) (F.) is only serious when it appears in the early part of the season, affected plants losing their vitality early in life. The leaves have a powdery appearance, while the stems may also be similarly affected. To deal with this disease the grower should practise:

(1) Removal of affected plants.

(2) Spraying with liver of sulphur, 1 oz. to 3 gal. of water, or dusting with finely-divided sulphur.

(3) Adequate watering. The soil should never be allowed to become very dry.

REFERENCES

OGILVIE, L., and MULLIGAN, B. O.: *Report of the Agricultural and Horticultural Research Station, Bristol*, 1930, pp. 144–6.

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

Anthracnose (*Colletotrichum lagenarium*) (F.), a disease that principally affects the cucumber, may sometimes attack the vegetable marrow when grown in frames. Reddish spots appear on the leaves of attacked plants. The stems and marrows may also be attacked, causing considerable losses.

(1) As a prevention under glass high humidity should be avoided.

(2) If the attack is considered sufficiently severe, a lime-sulphur spraying may be given.

REFERENCE

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries. (Under "Cucumber Diseases".)

Blotch (*Cercospora melonis*) (F.). This disease may attack marrows grown in frames. For symptoms and control see melon diseases.

Mosaic (V.). This disease has only appeared in recent years, but seems to be spreading rapidly throughout the country. The symptoms are mottling of the foliage with a certain amount of distortion. Affected plants are stunted, and any fruits that are formed are also mottled and irregular.

Plants so attacked bear very small crops, and should be removed to prevent the spread of the disease to healthy plants.

REFERENCES

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

OGILVIE, L., and MULLIGAN, B. O.: *Report of the Agricultural and Horticultural Research Station, Bristol*, 1933.

OGILVIE, L., MULLIGAN, B. O., and BRIAN, P. W.: *Report of the Agricultural and Horticultural Research Station, Bristol*, 1934.

Collar Rot. The stems rot off at the base, or immediately behind the fruits. This trouble is not regarded as a disease, but is chiefly induced by bad watering. Care should be taken in the early stages not to use cold water, or to splash water about indiscriminately. Water should be kept away from the base of the stem.

Powdered charcoal and quicklime mixed in equal parts, and placed around the base of the stem, will help to prevent the trouble.

REFERENCE

Vegetable Diseases, Bulletin No. 68, Ministry of Agriculture and Fisheries.

WATERCRESS

Mosaic (V.) on watercress was first recorded in 1935 when suspected plants were sent to the Cheshunt Research Station.

Affected plants showed a yellow mottling of the leaves, which were also somewhat deformed, while the plants were slightly stunted. It was not found possible to transmit this disease by aphis.

Later in the year another plant from a different source was sent in, suffering from what was thought to be the same disease. There was a similar mottling of the leaves, with a more severe stunting of the plant. This virus was proved to be cucumber virus type, and produced the characteristic mottling on the cucumber.

(1) Cuttings should be taken only from healthy plants.

No other control measures have so far been worked out.

REFERENCE

AINSWORTH, G. C.: *Report of the Experimental and Research Station, Cheshunt*, 1935, p. 61.

PESTS

BEAN (FRENCH OR KIDNEY)

Greenhouse White Fly (*Trialeurodes vaporariorum*) can be quite serious on beans grown under glass.

The foliage becomes mottled and may wither and die off. The fly, during feeding, excretes quantities of honey dew, which prevents the leaves from functioning properly. A fungus also develops on the honeydew, which causes the leaves, and sometimes the beans, to become very unsightly.

The white flies are too familiar to need description. Eggs are laid in groups and from these flattish larvæ are hatched. Before becoming adults they pass through four stages.

A parasite (*Encarsia formosa*) can do much to keep down the pest. It should be introduced as soon as the white fly makes its appearance. Inquiries for the supply of this parasite should be addressed to the Director, Experimental and Research Station, Cheshunt, or to the Director, R.H.S. Gardens, Wisley, Ripley, Surrey.

Fumigation with hydrocyanic acid gas has been quite successful. This is obtained either by exposing calcium cyanide to the air, or by the action of sulphuric acid on sodium cyanide. Sodium cyanide, calcium cyanide and hydrocyanic acid gas are all deadly poisons, and should be used with great care. For further particulars in the use of these substances see references below.

REFERENCES

ANON.: Advisory Leaflets Nos. 86 and 92, Ministry of Agriculture and Fisheries.

MILES, H. W. and M.: *Insect Pests of Glasshouse Crops*, Crosby Lockwood & Son, Ltd.

Red Spider (*Tetranychus telarius*) may cause considerable damage to beans grown under glass. The leaves become pale in colour and the vigour of the plant is reduced. As to control, see melon pests.

Root Knot Eelworm (*Heterodera marioni*) causes a swelling of the roots and can materially affect the yield of the crop. For life history and control see lettuce pests.

Thrips (*Thrips tabaci*) attack the under-surface of the leaves, causing the plant to become pale and unhealthy. For control, see melon pests.

Stem Eelworm (*Anguillulina dipsaci*). On peas and beans the attack commences on the stem just below soil level. The eelworm works upwards and the stem turns black and eventually rots, resulting in the death of the plant.

REFERENCE

ANON.: Advisory Leaflet No. 178, Ministry of Agriculture and Fisheries.

CARROT

Carrot Fly (*Psila rosæ*). The maggot of this fly bores into the carrot and in bad attacks renders them unsaleable. Carrots grown for the early market are not often attacked as the fly does not appear until about the middle of May. The foliage of attacked plants has a characteristic reddish-brown colour at the tips, later turning yellow and dying off. Secondary organisms may produce a soft rot in the carrots. These maggots often also attack the underground portions of celery and parsnip.

The fly is black, with a wing expanse of about ½ in. The eggs are laid near the carrot, and the maggot bores into the roots. They pupate in the soil and a second generation may appear. Notes on control are as follows:

(1) Removal of affected plants and adoption of a system of rotation. Avoiding growing carrots after or near celery or parsnips, if the attacks are serious.

(2) "Whizzed" or crude naphthalene. This should be broadcast over the bed at the rate of 2 oz. per sq. yd. to prevent egg-laying. Three or more applications are necessary at 10-day intervals, the first being given when the seedlings are well above the ground or at singling time.

(3) Sowing thinly to make thinning unnecessary. If thinning is practised the soil should be firmed around the plants afterwards to discourage egg-laying near the carrots and the thinnings should be destroyed.

(4) Sowing very early (e.g. in February in a sheltered position), or very late (e.g. mid-July), using an early variety, as such sowings frequently escape serious attacks.

REFERENCES

Anon.: Advisory Leaflet No. 68, Ministry of Agriculture and Fisheries.
Miles, H. W.: *Sci. Hort.*, 1935.

Carrot Aphis (*Anuraphis dauci*) has been known to attack the leaves of the carrot. The attacks are spasmodic and no control measures have been worked out, though it is reasonable to suppose that one of the non-poisonous contact sprays would be effective.

REFERENCE

Smith, K. M.: *Textbook of Agricultural Entomology.*

CAULIFLOWER

Cabbage Root-fly (*Chortophila brassicæ*). Affected plants become stunted and the leaves take on a bluish tinge. They are easily pulled out of the ground, as the root system is largely destroyed.

The fly is about ¼ in. long, not unlike a house-fly, and first appears in May. The eggs are small and are laid near the main root. The maggot, which causes the damage, hatches out in about 7 days, first eating the young roots, and later tunnelling into the larger roots. There may be two or three broods a year. Various substances have been used to secure control.

(1) *Naphthalene.* This should be sprinkled around the plants, two or three applications being made at fortnightly intervals, beginning just before or just after planting. This substance must not get on the plants.

(2) *Corrosive Sublimate* has given good results. The strength should be 1 oz. in 10 gal. of water, giving ¼ pint solution per plant just after they are put out. A second application should be given 14 days later.

(3) *Tar Distillate* has been tried in a few instances, but no definite results have been obtained. As a trial an approximate strength is 1 fluid oz. to 1½ gal. of water.

(4) *Tar Disks.* These are placed round the plants to prevent egg-laying. This is only practical on a small scale and where a good tilth can be obtained before the disk is laid.

All roots and stems of diseased plants should be destroyed after cropping. If attack is severe the cauliflowers should not be followed with another brassica crop on the same land. Some growers protect seedlings against the fly by placing over them frames covered with cheese cloth.

REFERENCES

ANON.: Advisory Leaflet No. 18, Ministry of Agriculture and Fisheries.
MILES, H. W.: *Sci. Hort.*, 1935.

Cabbage Caterpillars are the larvæ of the White Butterflies and/or of the Cabbage Moth. All of them feed on the leaves and curds, often rendering the latter worthless.

The Large White Butterfly (*Pieris brassicæ*) lays eggs in April or May. The caterpillars are greenish-black, with a yellow line down the back; they pupate in a month, and in about four weeks appears a second brood, which is usually the more serious.

The Small White and Green-veined White Butterflies (*Pieris* spp.) have a life history similar to that of the large White Butterfly. Caterpillars of both are green with slight differences.

The Cabbage Moths are a dirty brown colour with white markings. They appear in May and fly only at night, laying their eggs singly. The caterpillars are a light green colour but later take on a mud-brown colour. There are usually two broods per season. Among control measures:

(1) Hand-picking is an excellent method in small gardens, and if carried out in the early stages of attack may be worth while on a large scale, lads being paid a certain rate per 100 caterpillars caught.

(2) Spraying with derris products (which are non-poisonous) has proved fairly satisfactory. The maker's directions should be followed.

Apparently little work has been done on the possible use of deterrents for these insects. Instances have been reported in which a lime-sulphur spraying at strength 1–100 has kept away the butterflies from brassica crops, but there does not appear to be any scientific experimental authority.

REFERENCE

ANON.: Advisory Leaflet No. 69, Ministry of Agriculture and Fisheries.

Cabbage Aphis (*Brevicoryne brassicæ*) in some seasons is a serious pest, rendering the cauliflower unsaleable. The aphis penetrate the hearts of the plants and distort the leaves.

The insects are mauve-blue in colour. They overwinter usually in the egg form, the young aphides hatching out in February or March, to attack the young cauliflowers.

Removal of all old crops will assist in preventing the pest from spreading. (Brussels sprouts are often seriously attacked.) Dusting with a 3 per cent nicotine dust early in the life of the crop has been found to be effective. More than one application may be necessary. A Ministry of Agriculture Order (1937)now makes it compulsory for this pest to be controlled in the counties of Bedfordshire, Huntingdonshire and Cambridgeshire.

Slugs can do serious damage to the young plants soon after they have been put out. For control methods see lettuce pests.

Turnip Gall Weevil (*Ceutorrhynchus pleurostigma*). Whether this pest causes any serious damage to the roots of the cauliflower is a debatable point. The life history and control can be found under turnip pests (p. 212).

Turnip Flea Beetles (*Phyllotreta* spp.) may cause serious losses among young seedlings. The damage that they do, their life history and their control, can be found under turnip pests (p. 212).

Wireworms (see lettuce pests, p. 201).

Cabbage White Fly (*Aleurodes brassicæ*) produces yellowing of the leaves, and a reduction in the vigour of the plants. The presence of the fly in great numbers on the produce when marketed is objectionable to the buyers.

Eggs are laid on the leaves, and larvæ are hatched out in about 14 days. Pupation takes place in about 10 days, from which the adults emerge in about a week. In the warmer parts of England they often overwinter as adults and continue to breed.

Affected leaves and plants should be removed. Spraying several times with soap and water has been recommended, and it is possible that derris dusts would effect some control.

REFERENCES

SMITH, K. M.: *Textbook of Agricultural Entomology*. Bulletin No. 66, Ministry of Agriculture and Fisheries.

CELERY

Celery Fly (*Acidia heraclei*). The maggot bores between the upper and lower skins of the leaf, producing blister-like patches. In bad attacks the leaves may be completely destroyed.

The flies appear in April and May. The eggs are laid on or in the leaves; pupation of the larvæ takes place after about 4 weeks, and a second generation appears about a month later. There may be two or three broods per year.

(1) All affected leaves or leaflets should be removed as soon as they are observed, and badly attacked seedlings should be burnt.

(2) Rotation of crops should be practised, and celery should not be grown near parsnips, as the latter are also subject to attack. All debris following infected celery or parsnip crops should be collected and burnt.

(3) Soot is a good deterrent against the fly and should be sprayed on wet. Many applications are required to keep the

pest down. Paraffin emulsion may also be used, but one of the most effective and easily mixed deterrents is 1 per cent Jeyes Fluid. Spraying with nicotine (¾ oz. of nicotine, ½ lb. of soft soap and 10 gal. of water) is worth a trial, especially early in the season. It is usually advisable to apply these preparations at intervals of about 14 days.

REFERENCE

ANON.: Advisory Leaflet No. 87, Ministry of Agriculture and Fisheries.

Carrot Fly (*Psila rosæ*). The maggot of this fly sometimes does a certain amount of damage to the roots of celery. For the description and life history see the carrot pests (p. 196).

Celery should not be grown near the carrots, and a system of rotation should be practised.

LETTUCE

Wireworms (*Agriotes* spp.) are the larvæ of the "click beetles". They feed on the stems and roots of seedlings and mature plants at or below ground level. Lettuce plants are frequently attacked by wireworms burrowing into the stems and feeding there. The plants wilt and die.

The beetles are brown or blackish in colour, about ½ in. long and ⅛ in. wide and lay their eggs from May to July. The wireworms are easy to recognize by their bright yellow colour, distinct head and three pairs of legs. They may live in this stage for 4 or 5 years, before emerging as adult beetles.

Clean and thorough cultivation should be practised. On newly-ploughed land where attacks are often very bad, especially during the second, third and fourth years after ploughing, potatoes or an immune crop such as flax or mustard should be grown. During the first year after ploughing, the wireworms are apparently content to feed on the grass, roots and stubble turned into the soil. It is advisable to avoid adding new loam to frame composts unless it has been sterilized.

Trapping may be practised by various methods:

(1) Many adult beetles may be caught by means of cardboard smeared with treacle placed face downwards on the soil. (2) Some larvæ may be trapped by means of cut turnips, potatoes or carrots, placed on, or partially buried in, the soil. They are examined each morning and then the "catch"

destroyed. (3) Germinating wheat seedlings are particularly attractive to wireworms. Seed is drilled in and when numbers of the pest are seen to be attacking the wheat seedlings they may be carefully lifted together with the adjacent soil and the whole burnt. Under some conditions it is possible to destroy the wireworms by the application of calcium cyanide to the germinating wheat. This is drilled along the bait rows 2 or 3 in. deep with a seed drill at the rate of 1 lb. to 50 yd. It must be well covered to retain the gas evolved. (4) Strips of turf, preferably sterilized, placed amongst the plants, are attractive to the pest.

Deterrents or substances applied to the soil to drive the wireworms away from the vicinity of the crop plants, may also be used. Various proprietary articles are on the market, and crude naphthalene has been tried with varying degrees of success.

The destruction of the pests by partial sterilization of the soil by heat is often practicable and very effective in glasshouses and frames, and in composts.

REFERENCES

ANON.: Advisory Leaflet No. 199, Ministry of Agriculture and Fisheries.
MILES, H. W. and M.: *Insect Pests of Glasshouse Crops.*
MILES, H. W.: *Sci. Hort.*, 1935.

Root-Knot Eelworm (*Heterodera marioni*). This pest rarely attacks lettuce, but instances have been reported in which plants grown in glasshouse soils become infested with the pest, following infested tomato crops. As the name implies, the roots become swollen and distorted. The leaves turn yellow and badly-attacked plants die.

Within the gall will be found minute heart-shaped bodies, which are the female eelworms. They produce hundreds of eggs, from which microscopic worm-like bodies are hatched out. They enter the root, feeding on the inner tissue, and later the adult eelworms are formed. Individual eelworms cannot be seen with the naked eye.

For control there should be good conditions for growth, i.e. plenty of light and suitable ventilation if the plants are grown under glass. The soil should be well worked and excessive manuring avoided. Crop rotation should be practised.

Under glasshouse conditions steam sterilization of the soil is the most effective control method.

REFERENCE

MILES, H. W. and M.: *Insect Pests of Glasshouse Crops.*

Millepedes (*Blanjulus guttatus*, *Julus niger*, *Polydesmus complanatus*, and others). These sometimes cause the death of newly-planted seedlings by gnawing at the base of the stem or by eating the roots. They are somewhat similar to the larvæ of many insects, but have many more legs. They can be distinguished from centipedes because they have two pairs of legs on each segment, centipedes having only one pair per segment.

Millepedes are often rather sluggish in habit and when disturbed coil themselves up like a spring, but centipedes are very active and run quickly when disturbed. Millepedes are harmful to plant life, centipedes are beneficial.

Where the numbers are small, trapping with cut potatoes or mangolds is a very useful control method. Flaked naphthalene or naphthalene dust at the rate of 4 oz. per square yard will act as a deterrent. Adequate drainage should be carried out if necessary, and liming is beneficial. Rubbish heaps are often important breeding grounds.

In frames and in glasshouses a satisfactory control may be obtained by soaking the ground with a solution of 1 oz. of nicotine in 20 gal. of water with enough soft soap to make a lather. If soil sterilization by heat is possible this will destroy the millipedes.

REFERENCES

ANON.: Advisory Leaflet No. 150, Ministry of Agriculture and Fisheries.
MILES, H. W. and M.: *Insect Pests of Glasshouse Crops.*

Aphis, Greenfly, etc. (*Macrosiphum solani*, *Myzus lactucæ* and other spp.). These are troublesome pests under glass, particularly in the north of England, and may be very serious out of doors during seasons of drought.

The life history is similar to that of the other aphides. The aphides multiply exceedingly rapidly under suitable conditions and there is considerable overlapping of the broods.

Fumigation with hydrocyanic acid gas or with nicotine is effective in glasshouses. Lettuces should not be marketed until a few days after fumigating. Calcium cyanide is the easiest form in which to apply the former. Doses varying from ⅛ to ½ oz. per 1,000 cubic ft. are applied, depending on the condition of the house and the plants. The cyanide should be applied after sunset on the dry paths, when the foliage is quite dry and the soil not too wet. Water tanks should be covered and a temperature of 60° to 70° F. maintained. The houses must be ventilated before the sun shines on the plants. In frames these conditions are difficult to obtain, and if cyanide or nicotine is used a small trial should first be made in case damage is caused to the plants. Spraying is almost impracticable owing to the difficulty of getting the spray fluid on to the insects that are underneath and in between the leaves. The application of nicotine or derris dusts is almost as difficult, though this is sometimes worth a trial. When lettuce are only slightly infested they may be dipped and washed in a tub containing a solution of common salt before marketing.

REFERENCE

MILES, H. W. and M.: *Insect Pests of Glasshouse Crops.*

Lettuce Root Aphis (*Pemphigus bursarius*). Affected roots are covered with a woolly substance secreted by the aphides. In bad attacks it may result in the death of the plants. The insects winter either on the roots of the lettuce or in the egg stage on poplar trees. The winged aphides leave the galls they form on the leaves of the poplar about July, and place their young near the roots of the lettuce.

Control includes the removal of affected plants, and other hosts (e.g. sow thistles), and dressing the ground with naphthalene, which should be dug into the soil. Out of doors, where the pest is worst during dry seasons, overhead irrigation provides the best control method.

REFERENCES

SMITH, K. M.: *Textbook of Agricultural Entomology.*
THEOBALD, F. V.: *Jour. Roy. Hort. Soc.*, 1925, Part I.

Slugs are often troublesome to young seedlings that have been planted out. They are too well known to need description, but the tiny black kinds, about ⅛ to ¼ in. long, often escape observation.

Traps may consist of such things as cut potatoes or cabbage leaves, and if they are examined regularly, and the slugs are destroyed, the number can be appreciably reduced.

Copper sulphate has given good results, but care in use is necessary; 6 lb. of copper sulphate should be mixed with 1 cwt. of kainit and distributed at the rate of 3 cwt. per acre. It is possible, however, that continued applications of this substance may lead to the accumulation of copper compounds in the soil to an extent likely to be injurious to plant growth.

A mixture of Paris green and bran is a poison bait that has given varying degrees of success; 1 lb. of Paris green should be mixed with 20 lb. of bran, the bran being moistened gradually, using approximately 1 gal. of water.

A mixture of "Meta" and bran (Meta being a proprietary article that is a widely-used fuel for methylated spirit lamps) has been found to be very effective against slugs, and can be strongly recommended. One tablet of "Meta" is crushed up to a fine powder and thoroughly mixed with 1 pint of bran. The mixture is placed in heaps or broadcast alongside the plant, preferably on damp warm evenings. It is best to apply occasional dressings, as after a few days it may lose its effectiveness. It has been reported to be poisonous to birds, but any chance of injury may be avoided if the heaps are covered with pots or slates. Apparently birds do not feed from the material when it is broadcast thinly. It is not scheduled as a poison, but care should be taken that the tablets are not eaten by children.

REFERENCE

ANON.: Advisory Leaflet No. 115, Ministry of Agriculture and Fisheries.

Chafer Larvæ or "White Grubs" (e.g. *Melolontha vulgaris* and *Phyllopertha horticola*). The larvæ of the Chafer Beetles occasionally feed on the roots of lettuces, tomatoes and other crops, causing the plants to wilt. The grubs are comparatively large, fat and dirty white in colour. The head is brownish yellow. The grubs are usually found with their tail curled under the body. Control methods include: (1) Collecting by hand; (2) Baiting with germinating wheat; and (3) Application of naphthalene at the rate of 3 to 4 oz. per sq. yd.

Cut Worms or Surface Caterpillars (*Euxoa segetum*, *Graphiphora pronuba* and other spp.). These are the larvæ of certain species of night-flying moths, notably those of the Turnip Moth and the Yellow Underwing Moth. The caterpillars are usually a dirty greyish-brown colour and occasionally attack the base of the stems of seedling lettuces and other plants. Control methods include: (1) The use of a bran-Paris-green bait as recommended for slugs; (2) Trapping the moths by means of jars containing a mixture of 2 fluid ounces of ale and 1 fluid oz. of treacle with $\frac{1}{30}$ oz. (enough to cover a sixpence) of sodium fluoride.

Leather Jackets (*Tipula oleracea* and *T. paludosa*) are the larvæ of Crane-Flies or Daddy-Longlegs, and they sometimes attack the roots and stems of lettuces and other plants. The Leather Jackets are legless grubs about 1 to 1½ in. long, with tough, brownish or blackish skins. The following methods of control may be practised:

(1) The use of a bran-Paris-green bait as recommended for slugs.

(2) Trapping under squares of inverted turf half buried in the ground. Germinating wheat seed may also be used to attract the pests.

(3) The application of No. 16 grade naphthalene broadcast at the rate of 1 lb. per 20 sq. yd., worked into the soil.

(4) Constant cultivation of the soil.

The Glasshouse Symphylid (*Scutigerella immaculata* Newport) is commonly called "scooter", "glasshouse centipede" or "white insect". The creatures may attack lettuce under glass as early as November and continue until March. The roots are injured by surface gnawings or penetrating holes or they may even be severed. Roots become galled and gnarled. Attacked plants fail to thrive and often become infected with Botrytis. The crop presents a patchy appearance. This pest also attacks tomatoes, beans and cucumbers, sweet peas and other crops.

Glasshouse Symphylids are fragile, slender, white animals, about ¼ in. in length and difficult to find, as they are very active and quickly disappear in the soil. They have a distinct head with long antennæ, twelve pairs of legs and a pair of stout tail feelers.

In glasshouses control includes the sowing of a crop of rape or cress to attract the symphylids to the surface, raising the temperature of the soil and, after germination, steam sterilizing. Cresylic acid may be used instead, but it is not as efficient. Attacked plants may be watered with mercuric chloride (1 oz. to 10 gal. of water). Frequent surface cultivation discourages the pest.

REFERENCE

MILES, H. W. and M.: *Insect Pests of Glasshouse Crops.*

Lettuce Root Maggot (*Psila nigricornis* Meig.). The maggots pierce the plants at or below the collar and eat away the interior of the roots. Odd plants wilt here and there in the crop.

It is sometimes an important pest of chrysanthemums, attacking the roots similarly.

This pest is closely allied to and very similar to the Carrot Fly (*Psila rosæ*). The maggots are legless, tapering, shining, pale yellowish-white, slender and about ¼ in. long.

The pest is often introduced to glasshouses by infected chrysanthemum plants. For this reason the use of naphthalene on these plants when they are out of doors is suggested as a deterrent.

If a severe attack is expected it might be worth while to water the soil with a solution of 1 oz. mercuric chloride in 10 gal. of water before planting the lettuces.

REFERENCE

MILES, H. W. and M.: *Insect Pests of Glasshouse Crops.*

St. Mark's Fly (*Bibio marci*). The larvæ of this fly occasionally attack seedling lettuces, particularly when the soil is lacking in humus. The larvæ mine beneath the soil in frames, etc., and eat the roots of various vegetable crops, notably lettuce, causing similar damage to that caused by wireworms.

The larvæ are dark brown, hairy and about ½ to ¾ in. long when fully grown. They have the appearance of maggots and have no legs. Control includes:

(1) Adequate soil preparation and the addition of humus.

(2) Application of naphthalene to compost heaps in which the larvæ are often found.

(3) Application of soil fumigants to the frame beds before planting.

MELON

Red Spider (*Tetranychus telarius*). The mites feed on the under side of the leaves, causing the foliage to become yellow and mottled. In bad attacks the leaves wither away, sometimes resulting in the death of the plant.

The mite is very minute, about $\frac{1}{16}$ in. long. The females are bright red in colour, and overwinter in cracks and crevices. They start to attack the plants in glasshouses in March, and there are many successive generations of mites. The eggs are extremely small, and the larvæ that hatch out have only three pairs of legs. After several moults the adult is formed and has four pairs of legs.

(1) *Under Glasshouse Conditions*, as the spider prefers a dry atmosphere the house should be kept fairly moist and humid.

(*a*) *Fumigation with Pure Naphthalene.* This is done by means of special lamps. About 4 oz. of commercial pure naphthalene are required for each 1,000 cub. ft. of space. The fumigation should be started in the evening after the house has been damped over, and continued for 12 hours. The best results are obtained when the temperature is about 70° F.

(*b*) *Petroleum Emulsion.* Fairly good control has been obtained with these emulsions. They are of a proprietary nature and the maker's directions should be followed.

(*c*) *Liver of Sulphur.* This gives fairly good results (liver of sulphur 3 oz., soft soap ½ to 1 lb., water 10 gal.).

(*d*) When the crop has been cleared the house should be fumigated with "whizzed" naphthalene. This should be done by means of special lamps using 1 lb. of "whizzed" naphthalene per 1,000 cub. ft. of space.

(2) *Under Frame Conditions* the following treatment is advised:

(*a*) *Naphthalene* is only suitable as a control when the temperature of the frames can be raised sufficiently to make the substance effective against the mite (i.e. to 70° F.) and prevent any harmful effects.

(*b*) *Petroleum Emulsion.* This should be tried at 1 per cent strength and used rather sparingly, and at a time when the frames can be freely ventilated after spraying.

Heavy applications of white oil emulsion to the plants and woodwork at the end of the cropping season are also recommended. Washing down the frames and lights with 1 per cent cresylic acid and soft soap before storing should be a routine measure.

(*c*) *Derris and Pyrethrum Sprays* are worth a trial.

(*d*) When the crop is finished and before the plants are removed the frames should receive thorough treatment in an effort to destroy all pests on the plants and in the woodwork, etc. Where naphthalene can be effectively used this should be applied, keeping the frames closed for a few days (see also (*b*) above). Sulphur vaporization can be used similarly and gives a fair control.

REFERENCES

ANON.: Advisory Leaflet No. 224, Ministry of Agriculture and Fisheries.
MILES, H. W. and M.: *Insect Pests of Glasshouse Crops.*

Aphis (*Myzus persicæ*). Leaves become yellow and unhealthy and the vigour of the plant is reduced. The life history is complex, for all stages can be found on the plant at the same time. For small attacks the plants should be sprayed with nicotine at the rate of ½ oz. of nicotine (98 per cent purity) to 10 gal. of water and ½ to 1 lb. of soft soap. Where there is general infestation, fumigation with nicotine gives the best results.

REFERENCE

MILES, H. W. and M.: *Insect Pests of Glasshouse Crops.*

Thrips (*Thrips tabaci*). Infestation by Thrips cause bleached areas on the leaves. When the infestation is heavy the leaves die off completely. They may transmit virus diseases.

The adults are about 1/20 in. long, very narrow, and vary from greyish to brown. Eggs are laid in the leaves and the young thrips, usually yellowish in colour, hatch out in about a week. The thrips are adult in a month.

Good growing conditions should be provided and an ample supply of water given to the plants.

(*a*) *In Glasshouses.* Spraying with a petroleum emulsion has given good results. These are proprietary articles and the maker's directions should be followed.

Fumigation with hydrocyanic acid gas has been used successfully; ¼ oz. of commercial calcium cyanide should be used per 1,000 cub. ft. This is a poisonous substance, so that great care should be taken when using it. For further particulars see reference * below. Fumigation with Grade 16 naphthalene has been tried, but great care is necessary. This is broadcast over the plants at the rate of 10 oz. per 1,000 cub. ft.

(*b*) *In Frames.* Nicotine fumigation has been found quite effective in frames against thrips on melons and French beans.

REFERENCES

* ANON.: *Fumigation with Hydrocyanic Gas,* Advisory Leaflet No. 92, Ministry of Agriculture and Fisheries.
MILES, H. W. and M.: *Insect Pests of Glasshouse Crops.*

Wireworms may be brought in with the loam that is used to make up the beds. Only sterilized loam should be used.

(See also under lettuce pests.)

White Fly (*Trialeurodes vaporariorum*) is sometimes troublesome. For further particulars and control see bean pests.

Wood Lice (*Armadillidium speyeri*, etc.) are too common to need description. They gnaw the stem and roots near the soil level, causing the plants to wilt. The leaves may also be attacked.

The house or frame should be given a good spraying with cresylic acid before preparing the border (1 gal. of cresylic acid and 8 lb. of soft soap to 100 gal. of water).

Trapping may be done with inverted pots filled with straw, or halves of swedes, carrots, etc., placed on the soil. The pests may be collected and destroyed each morning by shaking them into a bucket containing boiling water or paraffin.

A poison bait may consist of 1 lb. of Paris green to 20 lb. of dry bran thoroughly mixed together, and applied at the rate of ½ to 1 oz. per sq. yd. No water should be added.

An even more attractive bait can be made by using ½ lb. of Paris green to 28 lb. of dried blood. (It should be noted that Paris green is highly poisonous to men and animals.)

Pyrethrum Dust has been found to be very effective against wood lice if dusted on to the soil when dry, and watering and damping-over withheld for a few days.

ONION

Onion Fly (*Hylemia antiqua*) is a very common pest in some districts. Plants that are attacked have a very poor root system and the leaves turn yellow and wilt.

The fly, which is grey and resembles a house fly, appears in early spring. It lays eggs near the base of the onion. The maggots are dirty white in colour and bore into the young bulbs at the base. Pupation takes place in the soil and there may be two or even three generations a year.

All attacked plants should be removed and a system of rotation carried out.

Various dressings have been tried, but have not always given really satisfactory results.

(1) Naphthalene broadcast over the bed at the rate of 2 oz. per sq. yd. is fairly effective.

(2) Paraffin emulsion has been tried (4 pints of paraffin, 1½ lb. of soft soap, 10 gal. of water). The soap should be dissolved in a little boiling water, the paraffin and the remaining water added, and then the mixture stirred vigorously. The solution should be sprinkled along the rows.

(3) Early planting and the use of a stimulating fertilizer, such as nitrate of soda, as top dressings is recommended.

(4) Recent experiments conducted by D. W. Wright * at the Horticultural Research Station, Cambridge, indicate that a good control may follow treating the seed with calomel (a compound of mercury).

A dilute solution (approx. 5 per cent) of a proprietary paste containing starch is prepared. The seed is placed in a non-metal container and the paste solution added at the rate of three-quarters of a teaspoonful per ounce of seed. After mixing thoroughly, so that all the seeds are moistened, calomel dust, equal to the weight of seed, is added and the whole well mixed. The treated seed is afterwards sown in the usual way.

(5) Autumn sowings and seedlings raised in boxes under glass for planting-out in spring, often escape attack.

REFERENCES

ANON.: Advisory Leaflet No. 163, Ministry of Agriculture and Fisheries.
MILES, H. W.: *Sci. Hort.*, 1935.
* WRIGHT, D. W.: "Control of Onion Fly", *Jour. Min. Agric.*, 1938, XLIV, 11.

Stem Eelworm (*Anguillulina dipsaci*) may cause the leaves of the young plants to become twisted and the whole tissue soft and flabby. If serious the whole crop may be destroyed.

The adults are about $\frac{1}{20}$ in. long, and therefore for practical purposes cannot be seen with the naked eye. Eggs are laid in the tissue of the plants and give rise to worms similar to the adults. When the host is dead, the worm either leaves it and attacks another plant, or becomes dried up with the plant, remaining in this condition for an indefinite period, but becoming active again under suitable conditions.

All affected material should be removed and burnt. Rotation can do a lot to keep down the pest, and infected land should not be planted with onions for at least two years, or with other susceptible crops such as narcissi.

Plantains are also attacked by this pest, and therefore they should be kept down.

REFERENCE

ANON.: Advisory Leaflet No. 175, Ministry of Agriculture and Fisheries.

RADISH

The **Turnip Flea Beetle,** the **Turnip Gall Weevil,** the **Carrot Fly,** and the **Cabbage Root Fly** are all apt to attack radishes.

Their life histories and control may be found under their respective headings.

TURNIP

Flea Beetles (*Phyllotreta* spp.). Damage done is caused chiefly by the adults, which attack the seedlings as they come through the ground. When the plants have reached the rough-leaf stage they are comparatively safe unless growing conditions are bad.

There are three main species, all of which are small and very active. They overwinter in hedge bottoms, rubbish, etc., as adults, egg-laying commencing in April and going on until August. There are some differences in the habits of each species in regard to where they lay their eggs, etc., and there is still some controversy on this matter. Pupation takes place in the soil, and the adults appear in five or six weeks. The following control measures are suggested:

(1) Cleaning up of likely overwintering places, and keeping the ground clean.

(2) Very good results have been obtained by dusting with a derris compound or nicotine dust. The first application should be given about a week after sowing, and the second when the seedlings are through.

(3) In addition, flake naphthalene dressed with the seed when sowing at the rate of 4 oz. of naphthalene to 1 lb. of seed has been recommended.

(4) It should be remembered that other Cruciferous plants (including weeds) may be attacked by the pest, and rotation should be practised where possible.

(5) A light application of sulphate of ammonia as a stimulant is sometimes helpful.

REFERENCES

ANON.: Advisory Leaflet No. 109, Ministry of Agriculture and Fisheries.
MILES, H. W.: *Sci. Hort.*, 1935.

Turnip Gall Weevil (*Ceutorrhynchus pleurostigma*) is quite a common pest but seldom causes serious losses.

Galls are produced on the roots and these galls must be distinguished from the swellings caused by the Finger-and-Toe disease. The galls are hollow and often contain the grub, while the swellings caused by the disease are solid.

The weevils are about ⅛ in. long, blackish in colour, and appear in the spring. Eggs are inserted in the roots, and the grubs, which are white and curved, feed inside, one in each gall. The grubs bore their way out when fully fed, to pupate in the soil, usually in early spring.

Plants grown on good land are less apt to suffer from an attack. Affected material should be removed before the grubs have left the roots.

Top dressings of fertilizers to encourage quick growth are often helpful.

REFERENCE

ANON.: Advisory Leaflet No. 196, Ministry of Agriculture and Fisheries.

Cabbage Root Fly (*Chortophila brassicæ*) sometimes attacks turnips, feeding on the roots. See cauliflower pests (p. 197).

VEGETABLE MARROW

Wireworms and Slugs are often destructive, particularly to young plants. The control measures for these pests can be found under lettuce pests (p. 201).

Red Spider may do some damage to marrows under glass. For the life history and control of this pest see melon pests (p. 208).

Root-Knot Eelworm may cause swellings on the roots. For its control see lettuce pests (p. 201).

WATERCRESS

Mustard Beetle (*Phædon cochleariæ* Fab.) can do serious damage to watercress, the injury consisting of eating the leaves, which is done by both the larvæ and the beetles.

The beetle is blue in colour, ⅛ in. in length, and overwinters as an adult. Eggs are laid on the plants, and the larvæ are yellow, spotted with black. Pupation takes place in the soil and in a fortnight the adults appear. There are often two broods a year.

If the beds can be flooded this will destroy the pests. Watercress should not be grown near a mustard crop. If flooding is impossible, spraying with derris has been found to be effective. However, it must be realized that derris is poisonous to fish.

REFERENCE

ANON.: Advisory Leaflet No. 157, Ministry of Agriculture and Fisheries.

Appendix One

Grading, Packing, Marketing, Crop Recording, Accounting, Disposal

The man who has the ability to grow good produce and who also possesses an aptitude for business matters is indeed fortunate, for the two talents do not necessarily—or even commonly—go together.

All market growers desire to obtain the highest cash return for their produce, but too many of them are not really interested in the art of presenting their goods to the best advantage before the buyers. Many highly-skilled growers pay considerable attention to minute details of culture, but regard the gathering and marketing of their crops as a necessary nuisance. This attitude is understandable, but obviously most unwise in these days of keen competition. There are still a few growers who hold the view that the enhanced prices obtained for the produce are insufficient to justify the expenditure in labour and material involved when careful grading, cleaning, and packing are carried out. This has been disproved time and again, and the fact that the most successful growers invariably maintain a high standard of marketing, is perhaps the strongest argument in favour of it. Further, it is always noticeable, that during periods when the market is glutted, well-marketed goods always sell (although the price may be low), but ungraded and badly-packed produce remains unsold and is eventually thrown away.

Personal Supervision. Each grower should undertake, as far as is possible, to supervise personally the work of grading, packing and marketing the produce. He should privately assume responsibility for the condition in which his goods reach the consumer, no matter what marketing and distributing system is adopted. He has already spent much time and money in growing the crops, but this may be made worthless by careless work in selecting and packing the produce. Whatever system of distribution is utilized, the grower should always aim to make for himself a reputation for dependability, and then strive at all times and at all costs to maintain that hard-earned reputation. Thousands of packages from such growers are sold daily in the wholesale markets without either salesman or buyer troubling to inspect even a sample package. The name of the sender is regarded as a sufficient guarantee of good quality produce, graded and packed efficiently and honestly.

Planning the Cropping Programme. Successful marketing begins when seed is ordered for the crops, so that only the right kinds and varieties are grown, and sowings are made so that the produce is placed on the market at the right time. The grower who keeps abreast of the times and looks well ahead in planning his cropping programme, may sometimes reap rich rewards. For instance, he may note an important local or national event and plan to grow larger quantities of particular crops in order to meet an increased demand. He should always be prepared to give outstanding new varieties a trial so that if they are found to suit his soil and climatic conditions he may profit by them. The market grower should always endeavour to maintain a constant supply of all crops that he grows, over as long a period as possible.

Seed Book and Diary. Much information likely to be of value to the grower as the years go on, can be accumulated in a well-kept diary and seed book. The records should include the kind, variety, cost and quantity of seed, and from whom it was purchased. Dates of sowing, transplanting and marketing should also be recorded, together with the cash returns obtained, and any notes of importance on cultural details or weather conditions. Records should also include the quantity of seed used for each variety to plant up a certain area, so that eventually the grower is able to order and sow amounts sufficient to supply his requirements without involving much waste of seed, space and time.

Crop Costings and Profits. Many growers are shy of figures, but there is little doubt that sensibly-kept accounts can often be the means of a considerable saving for them. Unless some reasonably accurate system is used for ascertaining the cost of production and total cash returns obtained for each crop, the grower may unwittingly be producing some crops at a loss each year. Admittedly, costings are difficult to carry out under ordinary market-garden conditions, but it is surprising what can be done when the grower is really convinced of its importance. If the task is too great to be carried out on all crops, it would be at least worth while for crops that are believed to return only small profits. Costs of production should include such items as rent of land (for the period occupied by the crop), manures and chemicals applied, labour costs and other items. The length of time that a particular crop occupies the land is very important to the intensive grower, since the shorter the time, the more crops can be grown on the land in one season.

Methods of Marketing. The choice of any particular marketing system depends on the individual circumstances. The large grower almost invariably depends on the wholesale salesman, but small growers can often dispose of their produce in other ways with greater profit.

(1) THE WHOLESALE MARKET, through salesmen and commission agents. This is undoubtedly the most important of the various methods and is well established in this country. Some growers often feel that the salesman's commission and other charges are too high. It should be pointed out, however, that this system of marketing means that the grower has only one sales account with which to deal, and only one debtor. He is saved a considerable amount of work and worry involved in invoicing, booking (which means capital lying idle), collecting debts from various customers, and occasionally suffering losses from bad debts. It should be remembered also that the wholesale market is the chief centre for the distribution of foreign as well as home-grown produce. This means that large numbers of buyers attend the market regularly, since such a large range of products is obtainable there throughout the year. It also means that the British grower has to compete with the foreign imports, not only in respect of the quality of the crops but also in regard to its "presentation" (packing, grading, etc.).

Every grower would do well to pay an occasional visit to the wholesale market to see for himself the condition of his produce when offered for sale, and compare it with others for quality and effect. At the same time he can improve his acquaintance with the salesman and quite often learn much about the kind of produce the public wants and in what way he can better his packing methods. The standard of foreign imports is often very high, since poor quality produce is not worth the expense of transportation to this country. Fortunately the introduction in 1931 of tariffs on foreign horticultural crops has considerably improved the chances of obtaining good prices for home-grown produce.

Having once found a satisfactory salesman, the grower is well advised to send all produce consistently to him, and not keep changing from one salesman to another. On a large scale the grower will probably send to several markets in various parts of the country, but usually to only one salesman in each market. In the latter event, while advantage should be taken of any temporary differences in market prices, the grower should never omit to send at least a small consignment to each market to maintain his connexion and to assist the salesman.

Returnable and Non-Returnable Packages. Many salesmen are willing to provide the grower with market packages and labels free of charge. The grower is, however, obliged to send all his produce to this salesman, and cannot take advantage of better prices possibly obtainable in other markets. Also, "returnables" may serve to convey diseases or pests from one nursery to another.

Much work is involved in handling and checking the returnable "empties", since they are rather heavy, and transport charges are very high. The non-returnable "empties" have, therefore, gained enormous popularity during the last few years, particularly for salad crops. They are relatively inexpensive, and, being light, make little extra cost to the transport charges. They may also be bought as "sets", comprising the parts of a crate or box cut in lengths ready for making up. These sets can be stored in a small space, the boxes being made up as required, or during the winter months and on wet days to provide employment for the men.

Specialization. The wholesale market provides an excellent outlet for the disposal of large quantities of certain crops that the grower is able to produce particularly well by reason of his skill, aided by favourable soil and climatic conditions. Such a grower becomes well known as providing a certain and reliable source of supply for his particular crop, and he has no difficulty in selling his produce.

Knowing the Markets. Markets vary considerably in their demand, particularly regarding the kind and quality of produce required. There are also differences in the type and size of package or bunch preferred; and seasonal demands vary in different localities. The grower should be well acquainted with all these points.

(2) DISTRICT COLLECTING AGENTS AND BUYERS. In some specialized market-garden districts the produce may be disposed of by a type of middleman. He may purchase the produce outright, or undertake to sell it for the grower on a commission basis. Under either arrangement the agent collects and sells the produce in the wholesale market or direct to the retailer.

(3) DIRECT TRADING WITH RETAILERS. This effects a considerable saving to the grower, especially if the retailer undertakes to collect the produce from the grower. Transport charges, market porterage and tolls are avoided, and often there is some saving in packing costs. This method is only suitable for comparatively small growers.

(4) DIRECT SALES TO THE CONSUMER. The grower may also be a retailer, managing a shop in a large town. He is thus able to obtain full profits for the produce that he grows, though he seldom finds it possible to keep the shop adequately supplied at all seasons.

Small growers frequently dispose of much of their produce through a stall rented in the local town on market days, usually once a week.

Nowadays, the roadside produce stall is a familiar sight to motorists, and considerable quantities of fruit, vegetables and flowers are sold annually in this way. If the volume of business warrants it, a full-time assistant is employed at the stall. Alternatively a member of the family is in attendance or working within easy call.

When no shop or stall exists, it is seldom wise to sell very small quantities of produce to private individuals who call at the gardens at odd times during the day. These callers often take up so much of the growers' valuable time that each sale is in fact a loss.

Appendix Two

A Note to Private and Amateur Gardeners

The intelligent gardener will probably find little difficulty in adapting to his own conditions the commercial methods of salad production described in the foregoing pages. In these days, when the gardens of large estates are often understaffed owing to economic conditions, the head gardener may profitably adopt some of the labour-saving methods used by commercial growers.

Out-of-season salads have always been a feature in private gardens, and the modern Dutch light and the continuous cloche can be of considerable assistance in producing a succession of these crops throughout the year. Unfortunately, old private gardens frequently contain some glasshouses and frames which, from present-day standards, appear to have been built for strength rather than utility. Such structures often allow but little light to reach the plants, and are therefore not really suitable for early salad production. When salads such as lettuces are to be grown in deep garden frames, the level of the soil should be raised so that the plants grow near to the glass. In gardens, although the natural soil may be unsuitable, good quality salads may still be grown by the use of a prepared compost consisting approximately of

5 parts loam
2 parts sand
1 part well-rotted manure
1 part leaf-mould or moist peat-moss.

A little bone-meal or a well-balanced fertilizer may be added to the mixture, which should be thoroughly mixed and sifted through the ½-in. riddle.

Many gardens are sufficiently large to warrant the installation of some form of overhead irrigation. The portable spray-lines or pipes are very suitable, since they can be used for irrigating herbaceous gardens, lawns, etc., when not required in the vegetable garden.

Private gardeners are familiar with manure hot-beds, but the convenience and cleanliness of electricity for this purpose make a strong appeal. Some manufacturers offer small complete electrical soil-warming units made to fit a single-light frame.

Out of doors, salad crops are often successfully grown as catch-crops and intercrops between other vegetables. Lettuces are commonly grown between rows of peas and beans during summer, when the shade provided by the taller crops may check the tendency for the lettuces to "bolt" during drought. As a general rule, however, most salads require as much sunshine as possible, particularly during the shorter days. Salad crops such as lettuce or radishes are often sown in the same drills as carrots or parsley, since the former germinate more quickly and enable the grower to commence hoeing early. As "catch-crops" salads are useful to fill up odd spaces left vacant for a comparatively short time between major crops.

While salads form an accommodating crop in these ways, they cannot be grown to perfection unless thay are given good treatment as a major crop. This means thorough cultivation, adequate manuring, frequent hoeing, watering when necessary, and the control of pests and diseases. Particular attention should be paid to correct times of seed-sowing and the selection of suitable varieties for each season. Nowadays, salads form an important part of normal diet, and the modern housewife fully realizes their great value as sources of minerals, oils and vitamins essential to good health.

Appendix Three

United Kingdom Imports (in Tons) of Vegetables from France and the Netherlands, in each Month of the Years 1931, 1932, 1935 and 1936

(Figures in heavy type indicate that a proportion of the supply was raised in frames)

(1) SALADS

(Lettuce, Endive and Chicory)

	France				*Netherlands*			
	1931	1932	1935*	1936	1931	1932	1935	1936
January . .	**525**	**485**	**34**	**4**	—	—	12	11
February . .	**515**	**450**	**33**	**4**	—	—	2	4
March . .	**991**	**601**	**39**	**179**	**66**	**326**	**448**	**258**
April . .	**957**	**220**	**4**	**5**	**2,692**	**2,790**	**2,500**	**2,335**
May . .	191	37	5	7	**5,023**	**4,052**	**2,483**	**4,924**
June . .	73	14	5	5	1,312	1,404	471	687
July . .	28	4	7	5	16	34	64	4
August . .	15	3	4	3	7	19	85	1
September .	7	2	4	3	63	11	78	4
October . .	6	2	3	3	37	6	103	34
November .	17	4	28	25	260	110	196	196
December .	**255**	**63**	**13**	**300**	**64**	**188**	**77**	**66**
Total .	3,580	1,885	179	543	9,540	8,940	6,519	8,524

**Note.* In 1935 the exports of vegetables from France were heavily restricted owing to the spread of the Colorado Beetle.

(2) CAULIFLOWERS

	France				*Netherlands*			
	1931	1932	1935	1936	1931	1932	1935	1936
January .	4,486	3,845	1,225	1,058	—	—	—	4
February	7,216	1,835	1,878	3,825	—	—	—	—
March .	6,395	1,800	494	3,550	—	—	—	—
April .	7,071	2,600	436	2,280	**20**	—	**5**	**30**
May .	2,150	2,080	—	384	**218**	**46**	**91**	**470**
June .	50	—	4	—	**1,812**	**1,146**	**797**	**1,344**
July .	—	—	—	—	1,353	750	63	256
August .	—	—	—	—	341	113	7	3
September	5	—	—	—	112	4	6	—
October	137	—	1	1	95	61	3	4
November	2,698	70	58	3	208	7	1	5
December	3,082	95	167	268	31	3	53	194
Total	33,290	12,325	4,263	11,369	4,190	2,130	1,026	2,310

	(3) CARROTS				(4) ASPARAGUS			
	Netherlands				*France*			
	1931	1932	1935	1936	1931	1932	1935	1936
January .	1,826	2,610	1	1,162	**4**	**4**	—	—
February .	1,542	1,760	1	3,063	**10**	**2**	—	—
March . .	1,781	2,880	7	1,547	**29**	**22**	—	—
April . .	**932**	**944**	**36**	**900**	302	84	—	—
May . .	**1,236**	**457**	**398**	**547**	782	233	—	—
June . .	**1,953**	**1,752**	**1,591**	**1,900**	515	133	—	—
July . .	1,100	905	1,081	889	33	15	—	—
August . .	1,184	967	618	533	1	—	—	—
September .	1,322	987	586	58	—	—	—	—
October .	1,524	542	451	9	—	—	—	—
November .	1,615	260	425	20	**1**	**1**	—	—
December .	1,375	296	521	11	**3**	**1**	—	—
Total .	17,390	14,360	5,716	10,639	1,680	495	203	219

In addition to the four vegetables of which statistics of imports are given, produce grown in frames and imported into the United Kingdom included also the following:

Turnips. Early forced turnips, mainly of the long type imported from France from April to June inclusive. A smaller proportion of early turnips, chiefly of the round varieties, grown in Holland, and imported during June.

Cantaloup Melons. Melons grown in frames, imported from France in June, July and August, and from the Netherlands in July, August and September.

Strawberries. Early strawberries produced in frames, particularly in the Zwijndrecht and Westland Districts of Holland, and imported in May and early June.

Appendix Four

United Kingdom Import Duties on certain Fresh Fruits and Vegetables, January, 1938

Product	*Duration*	*Amount*	
Strawberries . .	April 1–July 31	3*d.*	per lb.
Asparagus . . .	January 1–end February April 16–June 30	4*d.*	,, ,,
	March 1–April 15	1½*d.*	,, ,,
Broccoli and cauliflowers	March 1–June 30	4*s.*	per cwt.
	July 1–end February	3*s.*	,, ,,
Carrots . . .	May 1–June 30	10*s.*	,, ,,
	July 1–April 30	2*s.* 4*d.*	,, ,,
Green Beans . .	January 1–August 31	1½*d.*	per lb.
Lettuce, Endive and Chicory (Salad) .	January 1–end February	5*s.*	per cwt.
	March 1–April 30	10*s.*	,, ,,
	May 1–December 31	8*s.*	,, ,,
Turnips . . .	May 1–June 15	8*s.*	,, ,,
	June 16–April 30	2*s.* 4*d.*	,, ,,
Tomatoes . . .	May 15–August 31	2*d.*	per lb.
	September 1–October 31	1*d.*	,, ,,
Cucumbers (other than gherkins) . . .	March 1–November 30	8*s.*	per cwt.

Appendix Five

Tables

Square Measure

144 sq. inches = 1 sq. foot
9 sq. feet = 1 sq. yard
30¼ sq. yards = 1 sq. perch, rod or pole
16 sq. poles = 1 sq. chain
40 sq. poles (1210 sq. yards) = 1 rood
4 roods (4840 sq. yards) = 1 acre
640 acres = 1 sq. mile

Land Measure

Land, or any surface of considerable extent having length and breadth, is measured by Gunter's Chain, which consists of 100 links, measuring 66 feet = 22 yards = 4 poles in length.

62·726 sq. inches = 1 sq. link
2·295 sq. links = 1 sq. foot
20·661 sq. links = 1 sq. yard
625 sq. links = 1 sq. pole or perch
40 sq. poles or perches = 1 rood
4 roods (4840 sq. yards) = 1 acre
10 sq. chains = 1 acre

Liquid Measure

4 gills = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon
36 gallons = 1 barrel

20 fluid ounces = 1 pint
1 tablespoonful = ⅝ fluid ounce
2 dessertspoonfuls = 1 tablespoonful
2 teaspoonfuls = 1 dessertspoonful

One Imperial gallon of water weighs 10 lb.

A cubic foot of water contains a little over 6 gallons and weighs 1000 oz.

To ascertain the cubic contents of a circular well or tank, multiply half the circumference by half the diameter, and multiply the result by the depth (or multiply the square of the radius by 3·1416 and then by the height). The total will give the number of cubic feet. This number multiplied by 6·2 gives the number of gallons.

Avoirdupois Weight

16 drams = 1 ounce
16 ounces = 1 pound
14 pounds = 1 stone
28 pounds = 1 quarter
4 quarters (112 pounds) = 1 hundredweight
20 hundredweights = 1 ton

Equivalent Dressings of Manures

Per acre	*Per sq. rod or pole (30¼ sq. yd.)*	*Per sq. yard (approx.)*
1 cwt.	¾ lb.	⅜ oz.
2 cwt.	1½ lb.	¾ oz.
4 cwt.	2¾ lb.	1½ oz.
6 cwt.	4¼ lb.	2¼ oz.
8 cwt.	5½ lb.	3 oz.

PLANTING TABLE

Number of Plants required for one Acre

Distance between Plants	Width of Drill					
Inches	6 in.	9 in.	12 in.	24 in.	27 in.	30 in.
9	116,160	77,440	58,080	29,040	25,816	23,232
12	87,120	58,080	43,560	21,780	19,360	17,424
15	69,696	46,464	34,848	17,424	15,488	13,940
18	58,080	38,720	29,040	14,520	12,908	11,616
21	49,782	33,189	24,891	12,444	11,040	9,956
24	43,560	29,040	21,780	10,888	9,680	8,712

Some Selected References

HALL, SIR A. D.: *The Soil* (Murray).

RUSSELL, SIR E. J.: *Soil Conditions and Plant Growth* (Longmans).

HOWARD, SIR ALBERT: "The Waste Products of Horticulture: Their Utilization as Humus", *Sci. Hort.*, 1935, III, 213.

HOWARD, SIR ALBERT: "The Manufacture of Humus by the Indore process", *Jour. Roy. Soc. Arts*, Nov. 22, 1935, **84**, 4331, pp. 26–59.

BROOKS, E.: "Soil Warming", *Estate Mag.*, Jan., 1937, p. 37.

Jour. Roy. Hort. Soc.:

"Plants in Health and Disease", Dr. W. F. Bewley, LIX, Part 4.

"Quality in Early Vegetables: a Symposium", LIX, Part 3.

"Salad Vegetables in the Private Garden", A. Payne, LX, Part 4.

"The Place of Vegetables and Fruit in Diet", G. E. Friend, LXII, Part 7.

Jour. Min. Agric.:

"Raising the Soil Temperature in Glasshouses", W. F. Bewley, 1934, XL, No. 11.

"Cheshunt Early Giant Lettuce", W. F. Bewley, 1935, XLII, No. 1.

"Natural Manure on the Continent", S. E. Scammell, 1936, XLII, No. 12.

"Cultivation of Chicory as a Vegetable", J. C. Wallace, 1936, XLIII, No. 2.

"Electrical Heating of Soil in Frames", C. P. Quarrell, 1936, XLIII, No. 5.

"The Cultivation of Winter Lettuce", H. Fairbank, 1936, XLIII, No. 5.

"Composts", H. V. Garner, 1937, XLIV, No. 4.

"Electrical Heating for Horticultural Purposes", C. A. Cameron Brown, 1937, XLIV, No. 6.

"Cultivation of Lettuce under Glass," N. J. Macpherson, 1932, XXXVII (Jan.).

"Marketing of Home-grown Lettuce", Anon., 1938, XLV, No. 2.

Cheshunt Experimental and Research Station Annual Reports.

Ann. Reps. of Agric. and Hortic. Res. Sta., Long Ashton, University of Bristol.

BEWLEY, W. F.: *Diseases of Glasshouse Plants.*

MILES, H. W. and M.: *Insect Pests of Glasshouse Crops*, 1935.

Ministry of Agriculture and Fisheries:

Salad Crops, Bulletin No. 55.

The Cultivation of Vegetables in Frames, Bulletin No. 65.

Celery Growing, Bulletin No. 47.
Tomatoes: Cultivation, Diseases and Pests, Bulletin No. 77.
Vegetable Diseases: A Brief Summary, Bulletin No. 68.
Practical Soil Sterilization, Bulletin No. 22.
Insect Pests of Crops, 1928–31, Bulletin No. 66.
Pests of Ornamental Garden Plants (G. F. Fox-Wilson), Bulletin No. 97.
Some Beneficial Insects, Bulletin No. 20.
Investigations on Celery Diseases and their Control, Bulletin No. 25.
Manuring of Vegetable Crops, Bulletin No. 71.
Manures and Manuring, Bulletin No. 36.
Artificial Fertilizers in Modern Agriculture, Bulletin No. 28.
The Use of Lime in Agriculture, Bulletin No. 35.
Cultivation of Cucumbers, Advisory Leaflet No. 127.
Marketing of Vegetables. Reports on Marketing (Orange Books), No. 25.
Markets and Fairs. Part I—General Review. Ditto, No. 13.
„ „ „ „ II—Midlands. Ditto, No. 14.
„ „ „ „ V—Wales.
„ „ „ „ VI—London. } Ditto, No. 26.
„ „ „ „ VII—Final Review.
Fresh Vegetables, Marketing Leaflet No. 58.
Agricultural Market Report (Weekly).

Horticultural Education Association Year Book (now *Scientific Horticulture*), 1933, **II**, 31, "Early Market Garden Produce", Secrett, F. A.

Scientific Horticulture (formerly *H.E.A. Year Book*), 1935, **3**, Taylor, H. V., Hoare, A. H., Secrett, F. A., Wright, S. J., Miles, H. W., Corbett, W., and others.

Scarlett, R. L.: *The Promotion of Soil Fertility and Health*, Proc. Roy. Cal. Hort. Soc. (Rep. of meeting at Edinburgh on 2nd March, 1937).

Secrett, F. A., and Bewley, W. F.: Two leaflets published by the Royal Horticultural Society, on "Salad Crops".

Secrett, F. A.: *Modern Methods of Vegetable Production and Marketing*, Jour. Roy. Soc. Arts, Dec. 13, 1935, **84**, 4334, pp. 126–155.

Hoare, A. H.: *Vegetable Growing for Market* (Crosby, Lockwood & Son, Ltd.).

Garner, H. V., Hoare, A. H., Long, H. C., Rayns, F., Stapledon, R. G., and Wallace, T.: *Profit from Fertilizers* (Crosby, Lockwood & Son, Ltd.).

Macself, A. J.: *French Intensive Gardening* (London, 1932).

Smith, T. (revised Shewell-Cooper, W. E.): *Profitable Culture of Vegetables*.

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